NWK DANA
TN
23
.U612
v.3
1996
pt.1

# MINERALS YEARBOOK

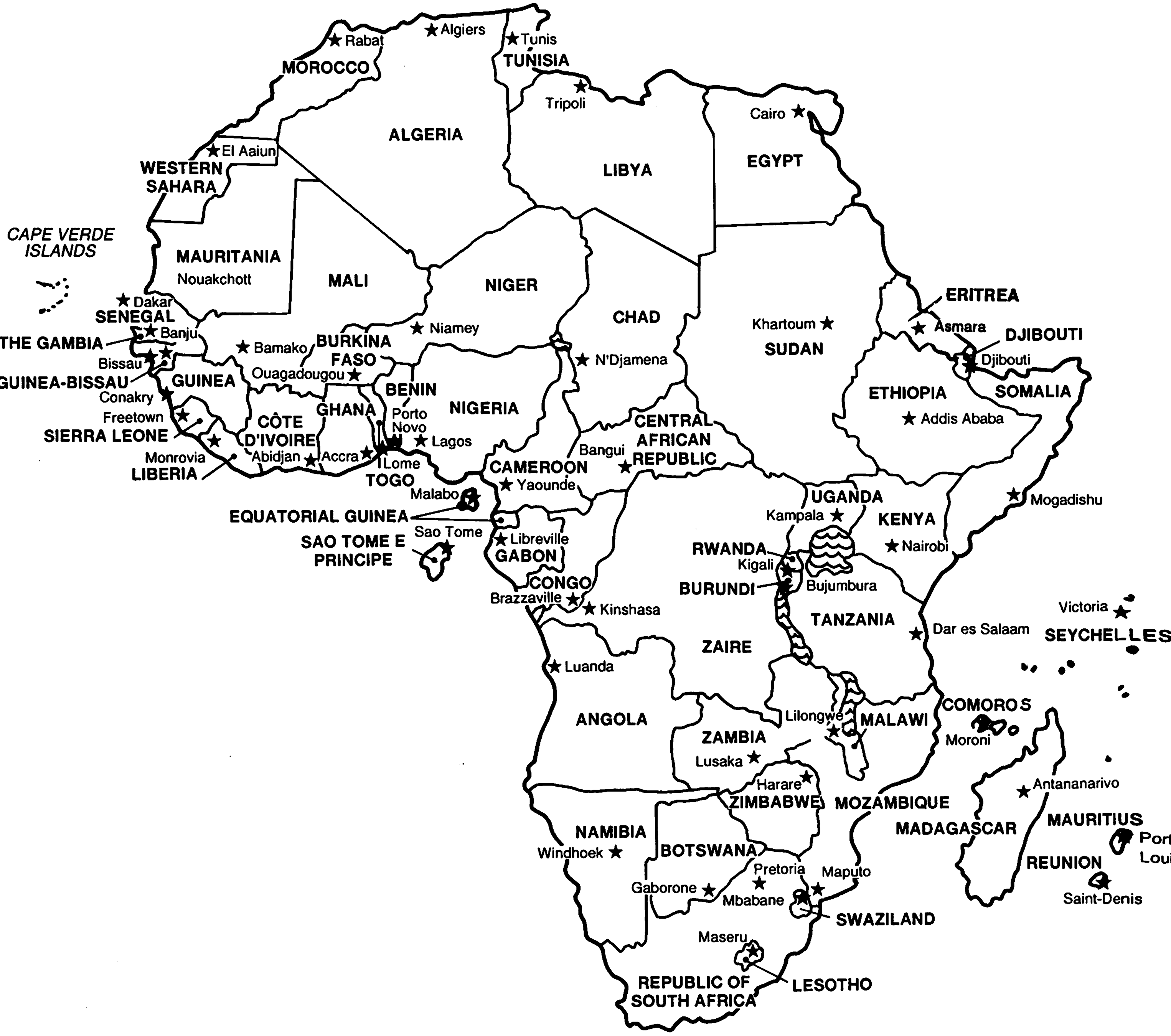
## *Volume III*

## AREA REPORTS: INTERNATIONAL 1996

## MINERAL INDUSTRIES OF AFRICA AND THE MIDDLE EAST

UNITED STATES DEPARTMENT OF THE INTERIOR

# AFRICA


Rabat
Algiers
Tunis
TUNISIA
MOROCCO
Tripoli
Cairo
ALGERIA
El Aaiun
WESTERN SAHARA
LIBYA
EGYPT
CAPE VERDE ISLANDS
MAURITANIA
Nouakchott
MALI
NIGER
CHAD
ERITREA
Dakar
SENEGAL
Banju
THE GAMBIA
Bissau
GUINEA-BISSAU
Bamako
BURKINA FASO
Niamey
Khartoum
SUDAN
Asmara
DJIBOUTI
Djibouti
N'Djamena
Ouagadougou
GUINEA
Conakry
BENIN
NIGERIA
ETHIOPIA
SOMALIA
Freetown
SIERRA LEONE
CÔTE D'IVOIRE
GHANA
Porto Novo
Addis Ababa
CENTRAL AFRICAN REPUBLIC
Lagos
Monrovia
LIBERIA
Abidjan
Accra
Lome
TOGO
Bangui
CAMEROON
Yaounde
Malabo
EQUATORIAL GUINEA
UGANDA
KENYA
Mogadishu
Kampala
Sao Tome
SAO TOME E PRINCIPE
Libreville
GABON
RWANDA
Kigali
Nairobi
BURUNDI
Bujumbura
CONGO
Brazzaville
Kinshasa
Victoria
SEYCHELLES
TANZANIA
Dar es Salaam
ZAIRE
Luanda
ANGOLA
COMOROS
Moroni
Lilongwe
MALAWI
ZAMBIA
Lusaka
Harare
Antananarivo
ZIMBABWE
MOZAMBIQUE
MADAGASCAR
MAURITIUS
Port Louis
NAMIBIA
Windhoek
BOTSWANA
REUNION
Pretoria
Maputo
Gaborone
Mbabane
Saint-Denis
SWAZILAND
Maseru
REPUBLIC OF SOUTH AFRICA
LESOTHO

I19. 165: 996/ V.3/ AFRICA 0639

# MINERALS YEARBOOK

## AREA REPORTS: INTERNATIONAL 1996

## MINERAL INDUSTRIES OF AFRICA AND THE MIDDLE EAST

## *Volume III*

Ref
TN
23
.U612
V.3
1996
pt 1
RLIN ID
# 94-81530

DEPOSITORY MATERIAL
DEC - 2 1998
JOHN COTTON DANA LIBRARY
RUTGERS THE STATE UNIVERSITY

U.S. GEOLOGICAL SURVEY

**U.S. DEPARTMENT OF THE INTERIOR**
**BRUCE BABBITT,** ***Secretary***

**U.S. GEOLOGICAL SURVEY**
**Thomas J. Casadevall,** ***Acting Director***

Any use of trade, product, or firm names in this publication is for descriptive purposes only and does not imply endorsement by the U.S. Government

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON: 1998

# Foreword

This edition of the U.S. Geological Survey (USGS) Minerals Yearbook discusses the performance of the worldwide minerals and materials industries during 1996 and provides background information to assist in interpreting that performance. Content of the individual Minerals Yearbook volumes follows:

- Volume I, Metals and Minerals, contains chapters about virtually all metallic and industrial mineral commodities important to the U.S. economy. Chapters on survey methods, summary statistics for domestic nonfuel minerals, and trends in mining and quarrying in the metals and industrial minerals industries in the United States are also included.
- Volume II, Area Reports: Domestic, contains a chapter on the mineral industry of each of the 50 States and Puerto Rico and the Administered Islands. This volume also has chapters on survey methods and summary statistics for domestic nonfuel minerals.
- Volume III, Area Reports: International, is published as four separate reports. These regional reports contain the latest available minerals data on more than 190 foreign countries and discuss the importance of minerals to the economies of these nations and the United States. Each report begins with an overview of the region's mineral industries during the year. It continues with individual country chapters that examine the mining, refining, processing, and use of minerals in each country of the region and how each country's mineral industry relates to U.S. industry. Most chapters include production tables and industry structure tables, information about Government policies and programs that affect the country's mineral industry, and an outlook section.

The USGS continually strives to improve the value of its publications to users. Constructive comments and suggestions by readers of the Minerals Yearbook are welcomed.

Thomas J. Casadevall
Acting Director

# Contacts

Information about the U.S. Geological Survey, its programs, staff, and products may be accessed on the World Wide Web at URL http://www.usgs.gov/. Aerial photography, digital data, geologic, and map products and information are available by contacting the Earth Science Information Center at 1-800-USA-MAPS. Water data and information may be obtained by contacting the Water Information Center at 1-800-426-9000. For specific information about this publication, contact the Chief, International Minerals Section, Minerals Information Team, at (703) 648-7732 or the Chief, Publication Services Section, Minerals Information Team at (703) 648-4750. Information about the Minerals Information Team may be accessed on the World Wide Web at http://minerals.er.usgs.gov/minerals/.

# Acknowledgments

The Country Specialists in the Minerals Information Team, U.S. Geological Survey, in preparing the International Review regional books of Volume III of the Minerals Yearbook, extensively use statistics and data on mineral production, consumption, and trade provided by various foreign government minerals and statistical agencies through various official publications. The cooperation and assistance of these organizations are gratefully acknowledged. Statistical and informational material was also obtained from reports of the U.S. Department of State, United Nations publications, and the domestic and foreign technical and trade press. Of particular assistance were the routine and special reports submitted by the 10 Regional Resource Officers assigned to minerals and petroleum reporting and by economic and commercial officers and other officials of the Department of State in U.S. Embassies worldwide. Their contributions are sincerely appreciated. Internal statistical support was provided by the staff of the Data Collection and Coordination Section of the Minerals Information Team.

The regimes of some countries reviewed in this volume may not be recognized by the U.S. Government. The information contained herein is technical and statistical in nature and is not to be construed as conflicting with or being contradictory of U.S. foreign policy.

**John H. DeYoung, Jr.**
**Chief Scientist, Minerals Information Team**

# Contents

Page

Foreword, by Thomas J. Casadevall ... iii
Contacts ... iv
Acknowledgments, by John H. DeYoung, Jr. ... v
Africa, by George J. Coakley, Bernadette Michalski, and Philip M. Mobbs ... 1
Algeria, by Bernadette Michalski ... 7
Angola, by George J. Coakley ... 11
Botswana by Henry E. Hilliard ... 13
Burkina Faso by William C. Butterman ... 19
Cameroon, by Philip M. Mobbs ... 23
Central African Republic, by Philip M. Mobbs ... 25
Chad, by Philip M. Mobbs ... 27
Congo, by Alfredo C. Gurmendi ... 29
Côte d'Ivoire, by Philip M. Mobbs ... 33
Egypt, by Bernadette Michalski ... 35
Eritrea, by Philip M. Mobbs ... 41
Ethiopia, by Philip M. Mobbs ... 43
Gabon, by Thomas S. Jones ... 47
Ghana, by George J. Coakley ... 51
Guinea, by Philip M. Mobbs ... 59
Kenya, by Philip M. Mobbs ... 63
Libya, by Bernadette Michalski ... 67
Madagascar, by George J. Coakley ... 71
Mali, by Philip M. Mobbs ... 73
Mauritania, by Bernadette Michalski ... 77
Morocco and Western Sahara, by Bernadette Michalski ... 79
Mozambique, by George J. Coakley ... 91
Namibia, by George J. Coakley ... 93
Niger, by Philip M. Mobbs ... 101
Nigeria, by Philip M. Mobbs ... 105
Senegal, the Gambia, and Guinea-Bissau, by Philip M. Mobbs ... 111
Sierra Leone, by Philip M. Mobbs ... 113
South Africa, by Thomas P. Dolley, and George J. Coakley ... 115
Swaziland, by George J. Coakley ... 135
Tanzania, by George J. Coakley ... 137
Togo, by Philip M. Mobbs ... 141
Tunisia, by Bernadette Michalski ... 143
Uganda, by Philip M. Mobbs ... 147
Zaire, by George J. Coakley ... 151
Zambia, by Thomas P. Dolley, and George J. Coakley ... 157
Zimbabwe, by Philip M. Mobbs ... 165
Other Countries of Africa, by George J. Coakley, Bernadette Michalski, Philip M. Mobbs, and Ebraham Shekarchi ... 173

The Middle East, by Bernadette Michalski and Philip M. Mobbs ... 183
Bahrain, by Bernadette Michalski ... 185

Cyprus, by Bernadette Michalski . . . . . 187
Iran, by William S. Kirk . . . . . 189
Iraq, by Larry Cunningham . . . . . 193
Israel, by Bernadette Michalski . . . . . 195
Jordan, by Bernadette Michalski . . . . . 197
Kuwait, by Bernadette Michalski . . . . . 199
Lebanon, by Bernadette Michalski . . . . . 205
Oman, by Bernadette Michalski . . . . . 207
Qatar, by Bernadette Michalski . . . . . 211
Saudi Arabia, by Bernadette Michalski . . . . . 215
Syria, by Bernadette Michalski . . . . . 223
Turkey, by Philip M. Mobbs . . . . . 227
United Arab Emirates, by Bernadette Michalski . . . . . 239
Yemen, the Republic of, by Bernadette Michalski . . . . . 243

## THE MINERAL INDUSTRY OF

# AFRICA

### By George J. Coakley, Bernadette Michalski, and Philip M. Mobbs

**Introduction**

The 55 countries of continental Africa and adjacent islands covered in this book encompass a land area of 30.27 million square kilometers, over three times the size of the United States, and had a 1996 population of approximately 743 million people. World Bank estimates of gross national product (GNP) per capita in Africa based on purchasing power parity data for 1995 ranged from a high of $9,600 in Libya to a low of $400 in Ethiopia, Rwanda, and Zaire. The GNP per capita in this mineral- and energy-rich region averaged about $1,800.

For many African countries, fuel and nonfuel mineral production and development constitute a significant part of the economy and remain a key to future economic growth. The continent is richly endowed in mineral reserves and ranks first or second in terms of concentration (from 23 to 89 percent) of world reserves of antimony, bauxite, chromite, cobalt, diamond, fluorspar, gold, hafnium, manganese, phosphate rock, platinum-group elements, titanium minerals (rutile and ilmenite), vanadium, vermiculite, and zirconium minerals. Except for bauxite (Guinea), cobalt (Zaire and Zambia), diamond (Angola, Botswana, Namibia, Zaire), and phosphate rock (Morocco) the bulk of these reserves are located in South Africa. Africa also possesses from 6 to 8 percent of the world's reserves of coal, copper, natural gas and petroleum and about 20 percent of world uranium reserves minable at a price not less than $80 per kilogram of uranium.

Natural resource development has proved vital to the economies of African nations because of its role in generating employment and foreign exchange and in providing the stimulus to develop the power and transportation infrastructure of the region. South Africa is one of the world's major mining and mineral-processing nations. Within the continent, the countries of subequatorial Africa comprised the dominant mineral-producing region. Mineral trade plays a significant role in African economies with mineral exports accounting for between 50% and 95% of total export earnings for Algeria, Angola, Botswana, Gabon, Guinea, Libya, Namibia, Niger, Nigeria, Zaire, and Zambia and between one-third and one-half of total export earnings for Egypt, Ghana, Jordan, and South Africa.

Historically, Africa has been a major supplier of strategic minerals to the United States and world markets. Africa accounts for between 11% and 45% of the world supply of eight major mineral commodities, chromite, cobalt, diamond, gold, manganese ore, crude petroleum, phosphate, and uranium *(see table 1)* and is a major producer of valued added processed materials, especially ferroalloys and aluminum. Most of Africa's mineral industries were export oriented and thus exposed to world market fluctuations. A number of African countries that were dependent on one mineral commodity, typically bauxite, copper, petroleum, phosphate, or diamond, were seeking to diversify their economies by developing downstream mineral-processing industries or additional mineral resources.

Africa is witnessing a major resurgence in mineral exploration and mineral project planning. According to the Metals Economics Group of Halifax, N.S., Canada, $418 million or nearly 12% of the combined exploration budgets of 223 companies were allocated for expenditure in Africa in 1996 (Metals Economics Group, 1997). This compares to World Bank estimates of exploration spending in Sub-Saharan Africa of about $280 million in the late 1980's. This increased attention by the world's minerals industry on Africa can be attributed to several factors:

1. The successful effort of the Multilateral Investment Guarantee Agency (MIGA), an arm of the World Bank, over the past 3 to 5 years in working with many African countries to put in place the more progressive mining and foreign investment laws that will attract foreign capital and technology.
2. The unprecedented success of Canadian stock exchanges in generating new capital for global exploration and mineral investment and channeled to Africa through Canadian junior mining companies.
3. Changes in the political climate which have enabled Angola and Mozambique to be reopened to exploration after years of civil war, a post-Apartheid South Africa look outward toward the rest of Africa for mineral investment opportunities, and efforts to privatize previously state-owned mineral holdings such as the Zambian Consolidated Copper Mines.
4. The perceived high probability for the occurrence of mineral resources on the continent, especially Sub-Saharan Africa, which has not been intensely explored in the past because of its high political risk.

Diamond exploration and development continued in Angola, Botswana, Namibia, South Africa, Zaire, and Zimbabwe, while the gold rush continued, especially in Burkina Faso, Côte d'Ivoire, Eritrea, Ethiopia, Ghana, Guinea, Mali, Niger, Tanzania, Uganda, and Zaire. Canadian, South African, and Australian companies were in the forefront of the current exploration activity in Africa. Most gold projects were still in the early drilling stages; however, potentially commercial gold resources were reported for the Bibiani, Damang, Obotan, Tarkwa, and Wassa deposits in Ghana, the Bulyanhulu, Golden Pride, Golden Ridge, and Geita deposits in Tanzania and the Siguiri deposit in Guinea.

The Central African Republic, Côte d'Ivoire, Guinea, and Senegal were also experiencing increased international investor interest in their gold resources. Gold output continued to surpass old production records in Ghana and Zimbabwe. In Ghana, Ashanti Goldfields emerged as a major force in African mining by investing over $500 million to acquire three companies with significant gold properties in Ghana, Burkina Faso, Guinea, and Zimbabwe. The acquired companies were International Gold Resources (Canada), Cluff Resources (U.K.), and Golden Shamrock (Australia). Ashanti corporate gold production increased to 32,000 kilograms in 1996, following its shift to a calendar year financial reporting. In Mali, the Sadiola Hill gold mine began production in December.

In 1996, about 498 metric tons of gold was produced in South Africa, the lowest in 40 years. The decline was attributed to aging, high-cost mines, declining ore grades, and lost productivity due to continued labor unrest. The depreciating value of the South African rand helped offset higher internal gold production costs and lower dollar export earnings. The South African gold industry continued to expand capacity at a number of existing mines, while major new mine developments, totalling $1.2 billion, were underway at Anglovaal Ltd.'s Target Mine and JCI Ltd.'s South Deep Mine. Iscor Ltd. of South Africa also planned to develop a new $360-million heavy minerals project in the Richards Bay area. Production of major South African export commodities—chromium, coal, diamond, iron ore, manganese, and platinum-group metals—remained within 3% of 1995 levels. Three large export-oriented projects entered their first full year of production with mixed success. Alusaf reached full production rate of 490,000 metric tons of aluminum by midyear at its Hillside smelter at Richards Bay. Anglo American's Namakwa Heavy Sands project experienced a setback in October with a furnace explosion at its 96,000-metric-ton-per-year (t/yr) high titanium slag and pig iron facility, which will remain out of commission until the first quarter of 1997. At the new 600,000-t/yr Columbus Stainless Steel plant, a joint venture between Highveld Steel, Samancor, and the Industrial Development Corporation, commissioning problems limited output to about one-half capacity.

The six major South African mining houses continued corporate "unbundling" and diversification of investments outside of South Africa, with a particular eye to new exploration and development opportunities elsewhere in Africa. As part of Black Economic Empowerment initiatives in South Africa, two African-owned commercial firms were established in 1996, stimulated by offers to purchase unbundled Anglo-American assets. The National Empowerment Consortium (NEC) gained control of Johnnic, Anglo's industrial investment company, for an estimated 2.1 billion rand ($450 million). The National Union of Mineworkers held a 13% interest in NEC. In a similar move in November, Anglo agreed to sell in principle 35% of the nonplatinum mining assets of JCI Ltd. to the African Mining Group Consortium for 2.87 billion rand ($620 million). In the policy arena, the South Africa Government was expected to release its Minerals Policy Green Paper by yearend. Expectations were that it would promote a positive environment for growth and employment in the mining sector.

Nations in both east and west Africa were actively promoting mineral development to the international investment community. In Nigeria, the new Ministry of Solid Minerals Development continued to develop its organization. The Zambia Privatization Agency, after lengthy internal government debate, issued an international tender to prospective investors to buy the mining and electricity distribution assets of the Zambia Consolidated Copper Mines Ltd. (ZCCM). By November 1996, 38 companies had prequalified to bid on the ZCCM assets which were broken up into nine packages including most of the combined Nchanga and Nkana Divisions, the Luanshya Division, the Mufalira Mine and concentrator, the Chambishi Mine, the Kansanshi Mine, the Nampundwe pyrite Mine, the Chambishi cobalt plant, the Ndola precious metals plant, and the ZCCM Electric Power Division. After 4 months of due diligence, final bids will be submitted, with winners likely to be announced by mid-1997. Proceeds from the sales will go to liquidate $500 to $600 million in ZCCM debts. ZCCM estimated that a $1.5- to $2-billion investment would be needed to maintain Zambia's role as a major world copper-cobalt producer. A company created by former ZCCM employees, Kabwe Power and Metal Company, acquired 100% ownership of the closed Kabwe lead-zinc mine and announced plans to restart production initially from old tailings. In other tailings reprocessing investments in Zambia, Colossal Resources of Canada continued to move forward with a 60% - 40% joint venture with the Zambian-based Qasim Mining Enterprises to reprocess 8.6 million tons of ZCCM's Nkana smelter slags containing an estimated 0.7% to 0.81% recoverable cobalt and 1.15% copper. The operation will produce up to 3,110 tons per year of cobalt using a two-stage process, either a reductive smelting in an open arc electric furnace followed by separation and hydrometallurgical extraction of cobalt or a Foxsmelt flash oxidation smelting process to produce cobalt ferroalloys directly. First Quantum Minerals Ltd. of Vancouver plans to invest $26 million on their Bwana Mkubwa project, which will reprocess ZCCM's Ndola No. 4 copper tailings using a leach, solvent extraction-electrowinning (SX-EW) process. Annual production is expected to be around 10,000 tons of copper and 60,000 tons of sulfuric acid that can be sold to nearby ZCCM operations. Also in Zambia, a consortium of ZCCM, Anglo-American, and Gencor were conducting feasibility studies on developing the 380 million tons of high-grade copper reserves in the Konkola Deeps Mine extension, Anglovaal Ltd. was exploring the adjacent Konkola North copper deposit, and the Canadian company, Caledonia Mining Corp.'s exploration led to the the discovery of 295 million tons of indicated and inferred cobalt resources grading 0.03% cobalt in three zones in the Nama area northwest of the Copperbelt and an additional copper-cobalt discovery at Kadola West, 40 kilometers south of Luanshya.

Additional activity in Africa's mineral industry included rutile exploration at Akonolinga in Cameroon, the investigation of the Biankouma-Touba nickel deposit in Côte d'Ivoire, and the development of new bauxite deposits and the resumption of diamond exploration in Guinea. In Kenya, Kenya Fluorspar Co.

Ltd. was privatized and Tiomin Resources Inc. of Canada was evaluating more than 1 billion metric tons of coastal sands grading 3% titanium-bearing minerals. An 180,000-t/yr-capacity aluminum smelter was under construction in Nigeria. Processing operations to recover cobalt from stockpiled pyrite concentrates at Kilembe in Uganda were underway. In Zimbabwe, mining began at the Hartley platinum mine during March 1996 and a number of additional platinum projects along the Great Dyke were being evaluated. A proposal was made to ship Zimbabwean iron ore by rail to Mozambique as part of a direct reduced iron project.

Civil war adversely affected mineral exploration and development in Burundi, Liberia, Rwanda, Sierra Leone, Somalia, and Sudan. In the Central African Republic, diamond production continued despite repeated attempted coups. In Sierra Leone, Sierra Rutile Holdings Ltd. remained closed in 1996 but reported little external damage to major equipment resulting from insurgent actions at the site in January 1995. Rutile production is expected to resume in 1997 or 1998. The Rwandan refugee movements and military actions in eastern Zaire affected supply routes through Bukavu for gold and other mining operations in Kivu Province, while incipient civil war and secessionists actions raised concerns for future copper-cobalt and diamond mining activities in Shaba and West Kasai Provinces.

Despite political uncertainties, most of 1996 saw increased foreign investor interest in the minerals sector of Zaire. The Canadian firm, Banro Resource Corp. acquired a 72% interest in the gold mines and properties of Societe Zairoise Miniere et Industrielle du Kivu (Sominki) and began plans for a $20 million development program. However, the Mobale gold mine near Kamituga in eastern Zaire was heavily damaged and normal supply routes through Bukavu were disrupted during fighting between the Zaire army and local insurgents late in the year. This action delayed further development plans. Sominki produced about 10,000 ounces of gold and 650 tons of tin per year and held reported minable reserves and geological resources in excess of 6.8 million ounces of gold in its Mobale Mine and Twangii, Lugushwa, and Namoya properties.

International Panorama Resource Corp. of Vancouver and its subsidiary, PTM Minerals (Cayman) Ltd., reached an agreement with Gecamines to obtain a 51% equity interest in and to acquire the rights to reprocess an estimated 61 million tons of tailings grading 0.98% copper and 0.19% cobalt from waste from the Kambove and Kakanda mines. Subject to final feasibility studies, a 17,000-ton-per-day vat-leach, SX-EW operation, costing up to $190 million, is planned for 1999. After a 30-year absence from Zaire, the Belgium company, Union Miniere, entered a 2-year long, joint venture with Gecamines to mine and refine 1,500 tons per year of cobalt from the Kasombo mine during 1996 and 1997. Gecamines continued to look for investors to reprocess similarly rich copper-cobalt tailings from the Kolwezi Mine and selected the Canadian firm, Consolidated Eurocan Venture's over the South African companies Gencor and Iscor Ltd. to reevaluate the feasibility for developing the Tenke-Fungurume deposit, one of the richest undeveloped copper-cobalt deposits in the world. Gecamines, meanwhile, continued to struggle to maintain copper production output at about 10% of capacity, while committing $100 million to rehabilitate the Kolwezi open pit copper mine. Elsewhere in Zaire, the U.S.-based, American Mineral Fields Inc. has entered conditional agreements with Gecamines and with Anglo American Corporation of South Africa to examine the feasibility of reopening of Gecamines' Kipushi zinc-copper mine, which closed in 1993. American Mineral Fields' Canadian consultants, Watts, Griffis, and McOuat Ltd. (WGM), estimated remaining minable proven and probable reserves of 22.6 million tons of ore grading 2.06% copper and 13.81% zinc (American Mineral Fields Inc, 1997). Barrick Gold Corporation also reached an agreement with the parastatal Office des Mines d'Or de Kilo Moto to rehabilitate their gold mining operations at Kilo Moto.

In Angola, foreign investors began to return in 1996 after that country's lengthy civil war appeared to be resolved. The diamond areas, previously controlled by the opposition forces of Uniao Para A Independencia Total De Angola (UNITA), in Lunda Norte and Lunda Sul Provinces and accounted for about $400 million out of Angola's annual national diamond output of $1.1 billion were opened to outside exploration and development companies in 1996. The state-owned diamond mining company, Empresa Nacionale de Diamantes de Angola (Endiama), issued exploration licenses or entered joint ventures for a number of projects. De Beers, after a 10-year absence from Angola, acquired a 5-year exploration right to evaluate the alluvial and kimberlite diamond potential in Cuando-Cubango Province. Endiama entered a joint venture with Sociedade Portuguesa de Emprendimentos in Sociedade Mineira de Lucapa's 8,000 square kilometer concession in the Camfue and Camiambo areas of Lunda Norte. Endiama also entered a joint venture with Brazil's Oderbrecht Mining Services and Russia's Almay Rossii-Sakha to begin production by late 1996 of over 900,000 carats annually from the Sociedade Mineira de Catoca's kimberlite holdings in Lunda Sul Province. American Mineral Fields acquired a 50% interest in a 3,700-square-kilometer diamond concession held by a Dutch West Indies security firm, International Defense and Security Forces, on the Luremo River near the border with Zaire. The Canadian company, Carson Gold Corp., and its subsidiary, Branch Energy Ltd., acquired majority interest in reported resources of over 10 million carats of diamond located in the Luo and Luarica concessions in Lunda Norte Province. The end of the civil war in Angola also brought renewed international interest in its offshore petroleum potential.

In north Africa, private investment has made significant contributions to the mining and metallurgical segments of the Egyptian and Moroccan economies. A number of major new industrial projects in cement, fertilizers, metals, and petrochemicals have attracted private investment capital. The Egyptian Aluminium Co. (EGYPTALUM) reduced Government equity in favor of private capital by 20% while continuing its expansion program, raising annual smelter capacity by 60,000 tons in 1997 to a total annual capacity of 240,000 tons. By contrast, two aluminum smelter projects, proposed by Algeria and Libya, have been indefinitely postponed because of security and finance problems—the Algerian Mostaganem 200,000-t/yr-capacity aluminum smelter and the Libyan Zwara 200,000-t/yr-capacity smelter.

Egypt's Alexandria National Iron and Steel Co. has embarked on an expansion and modernization program costing some $350 million. A series of contracts were awarded in the expansion program that should increase output capacity from 1.2 million metric tons per year (Mt/yr) to 1.5 Mt/yr. Expansion includes a $115 million second module of the Midrex direct-reduction plant, a $46-million expansion of the steelmaking plant, and a $40-million order to expand the rod mill plant. The expansion is scheduled for completion in 1997. The Canadian company, Inmet Mining Corp. has suspended mining and milling operations at the Bougrine zinc-lead mine in Tunisia. The capital investment required to reduce operating costs was reportedly not justifiable in the current price market. Morocco and Western Sahara host over 50% of the world's phosphate rock reserves and is the world's largest phosphate rock exporter. The Office Cherifien des Phosphates' Sidi Chennane Mine became operational in 1996 and should have a capacity of 5 Mt/yr by 1998.

The production of natural gas and petroleum and the refining of petroleum products were significant factors in the mineral economies of a number of African countries. Nigeria was Africa's largest oil producer, followed by Libya, Egypt, Algeria, Angola, and Gabon. Major oil companies and small independent oil companies were actively exploring offshore southern Africa and offshore from the West African nations of Cameroon, Côte d'Ivoire, Equatorial Guinea, Ghana, Guinea-Bissau, Nigeria, and Senegal. The commercial use of formerly flared natural gas in Nigeria was progressing rapidly. In Mozambique, development of the Pande natural gas fields were being held up over distribution rights into major markets in South Africa. Development continued in the Alba and Zafiro Fields, offshore Equatorial Guinea. Successful drilling of Chad's Doba Basin resulted in the proposal to run an oil export pipeline from Chad through Cameroon to the coast. In Sudan, State Petroleum Corp. was redeveloping the Heglig Field. South Africa, which has been dependent on synthetic fuels produced from coal, was prepared to start up its first commercial oil field in the Bredasdorp Basin offshore from Cape Town in January 1996.

Not all African countries were major mineral producers. In many African nations, the production of mineral commodities represented a minor part of the economy. Mineral output in these countries often was limited to the mining or quarrying of common construction materials such as clay, sand, and stone.

## References Cited

American Mineral Fields Inc, 1996, American Mineral Fields Inc. stock prospectus (Vancouver Stock Exchange): American Mineral Fields Inc., August 22, p.21-23.

Metals Economics Group, 1997, Overview of worldwide exploration expenditures: Metals Economics Group Strategic Report, September/October 1997, v. 10, n. 5, p. 1-5.

# TABLE 1
# AFRICA: PRODUCTION OF SELECTED MINERAL COMMODITIES 1/ 2/ IN 1996

(Thousand metric tons unless otherwise specified)

| Country | Aluminum e/ | Cement e/ | Chromite | Coal, anthracite and bituminous 3/ | Cobalt, mine Co content e/ (metric tons) | Copper, mine Cu content | Diamond (thousand carats) e/ 4/ | Gold e/ (kilograms) |
|---|---|---|---|---|---|---|---|---|
| Algeria | -- | 7,000 | -- | 22 | -- | -- | -- | -- |
| Angola | -- | 300 | -- | -- | -- | -- | 2,500 5/ | -- |
| Benin | -- | 380 | -- | -- | -- | -- | -- | -- |
| Botswana | -- | -- | -- | 852 | 406 5/ | 28 | 17,707 5/ | 5 |
| Burkina Faso | -- | -- | -- | -- | -- | -- | -- | 4,000 |
| Burundi | -- | -- | -- | -- | -- | -- | -- | 10 |
| Cameroon | 82 | 600 | -- | 1 | -- | -- | -- | 1,000 |
| Central African Republic | -- | -- | -- | -- | -- | -- | 470 | 90 |
| Congo | -- | 121 | -- | -- | -- | -- | -- | 10 |
| Cote d'Ivoire | -- | 500 | -- | -- | -- | -- | 75 | 1,000 |
| Egypt | 177 5/ | 18,000 | 1 | -- | -- | -- | -- | -- |
| Equatorial Guinea | -- | -- | -- | -- | -- | -- | -- | -- |
| Eritrea | -- | 47 5/ | -- | -- | -- | -- | -- | 98 |
| Ethiopia | -- | 700 | -- | -- | -- | -- | -- | 2,500 |
| Gabon | -- | 142 | -- | -- | -- | -- | 500 | 70 |
| Ghana | 137 5/ | 1,300 | -- | -- | -- | -- | 715 5/ | 49,211 5/ |
| Guinea | -- | -- | -- | -- | -- | -- | 205 | 6,838 5/ |
| Kenya | -- | 1,102 5/ | -- | -- | -- | -- | -- | 300 |
| Liberia | -- | -- | -- | -- | -- | -- | 150 | 700 |
| Libya | -- | 3,550 5/ | -- | -- | -- | -- | -- | -- |
| Madagascar | -- | 60 | 137 p/ | -- | -- | -- | -- | 500 |
| Malawi | -- | 140 | -- | 56 | -- | -- | -- | -- |
| Mali | -- | 15 | -- | -- | -- | -- | -- | 8,400 |
| Mauritania | -- | 375 | -- | -- | -- | -- | -- | 200 |
| Morocco | -- | 8,000 | -- | 651 | 565 5/ | 15 | -- | -- |
| Mozambique | -- | 30 | -- | 37 | -- | -- | -- | 6,800 |
| Namibia | -- | -- | -- | -- | -- | 15 | 1,420 5/ | 2,145 5/ |
| Niger | -- | 30 | -- | 170 | -- | -- | -- | 1 |
| Nigeria | -- | 3,000 | -- | 30 e/ | -- | -- | -- | 6 |
| Rwanda | -- | 10 | -- | -- | -- | -- | -- | 26 |
| Senegal | -- | 590 | -- | -- | -- | -- | -- | 600 |
| Sierra Leone | -- | -- | -- | -- | -- | -- | 270 | 16 5/ |
| Somalia | -- | 30 | -- | -- | -- | -- | -- | -- |
| South Africa | 617 5/ | 7,668 5/ | 5,137 5/ | 206,981 5/ | 350 5/ | 153 5/ | 9,946 5/ | 497,583 5/ |
| Sudan | -- | 380 | 15 e/ | -- | -- | -- | -- | 4,500 |
| Swaziland | -- | -- | -- | 144 | -- | -- | 70 | -- |
| Tanzania | -- | 800 | -- | 52 | -- | -- | 127 | 318 5/ |
| Togo | -- | 350 | -- | -- | -- | -- | -- | -- |
| Tunisia | -- | 4,567 5/ | -- | -- | -- | -- | -- | -- |
| Uganda | -- | 150 | -- | -- | -- | -- | -- | 2,954 5/ |
| Zaire | -- | 10 | -- | 10 | 2,000 | 29 e/ | 21,000 | 8,200 |
| Zambia | -- | 350 | -- | 373 | 7,900 | 334 e/ | -- | 130 |
| Zimbabwe | -- | 1,150 5/ | 697 | 5,175 | 110 | 10 e/ | 437 5/ | 24,699 5/ |
| Total, Africa 6/ | 1,013 | 61,447 | 5,987 | 214,554 | 11,331 | 583 | 55,592 | 622,910 |
| Total, world | 20,700 | 1,484,564 | 12,246 | 3,809,962 | 26,986 | 10,992 | 117,020 | 2,247,353 |
| Share of world total | 5% | 4% | 49% | 6% | 42% | 5% | 48% | 28% |
| United States | 3,577 5/ | 80,818 5/ 7/ | -- | 885,231 | -- | 1,918 | -- | 318,078 5/ |

See footnotes at end of table.

TABLE 1--Continued

AFRICA: PRODUCTION OF SELECTED MINERAL COMMODITIES 1/ 2/ IN 1996

(Thousand metric tons unless otherwise specified)

| Country | Iron ore (gross weight) | Lead, mine Pb content (metric tons) | Manganese ore (gross weight) | Petroleum, crude 3/ 8/ (thousand barrels) | Phosphate rock e/ (gross weight) | Steel, crude e/ | Uranium, concentrate $U_3O_8$ 9/ (metric tons) | Zinc, mine Zn content (metric tons) |
|---|---|---|---|---|---|---|---|---|
| Algeria | 2,245 | 1,016 | -- | 453,330 | 1,051 | 620 | -- | 5,912 |
| Angola | -- | -- | -- | 259,150 | -- | 9 | -- | -- |
| Benin | -- | -- | -- | 1,000 e/ | -- | -- | -- | -- |
| Botswana | -- | -- | -- | -- | -- | -- | -- | -- |
| Burkina Faso | -- | -- | 10 e/ | -- | -- | -- | -- | -- |
| Burundi | -- | -- | -- | -- | -- | -- | -- | -- |
| Cameroon | -- | -- | -- | 33,945 | -- | -- | -- | -- |
| Central African Republic | -- | -- | -- | -- | -- | -- | -- | -- |
| Congo | -- | -- | -- | 64,000 e/ | -- | -- | -- | -- |
| Cote d'Ivoire | -- | -- | -- | 6,000 e/ | -- | -- | -- | -- |
| Egypt | 3,000 e/ | -- | 15 e/ | 336,530 | 1,596 5/ | 2,618 5/ | -- | -- |
| Equatorial Guinea | -- | -- | -- | 7,300 | -- | -- | -- | -- |
| Eritrea | -- | -- | -- | -- | -- | -- | -- | -- |
| Ethiopia | -- | -- | -- | -- | -- | -- | -- | -- |
| Gabon | -- | -- | 1,980 | 134,000 | -- | -- | 620 | -- |
| Ghana | -- | -- | 789 | 2,190 | -- | -- | -- | -- |
| Guinea | -- | -- | -- | -- | -- | -- | -- | -- |
| Kenya | -- | 5 | -- | -- | -- | 20 | -- | -- |
| Liberia | -- | -- | -- | -- | -- | -- | -- | -- |
| Libya | -- | -- | -- | 511,365 | -- | -- | -- | -- |
| Madagascar | -- | -- | -- | -- | -- | -- | -- | -- |
| Malawi | -- | -- | -- | -- | -- | -- | -- | -- |
| Mali | -- | -- | -- | -- | 3 | -- | -- | -- |
| Mauritania | 11,360 | -- | -- | -- | -- | 5 | -- | -- |
| Morocco | 12 | 71,668 | 29 | 35 | 20,855 5/ | 5 | -- | 79,662 |
| Mozambique | -- | -- | -- | -- | -- | -- | -- | -- |
| Namibia | -- | 15,349 | 89 | -- | -- | -- | 2,890 | 33,955 |
| Niger | -- | -- | -- | -- | -- | -- | 3,160 e/ | -- |
| Nigeria | 100 e/ | 3,500 e/ | -- | 798,620 | -- | 20 | -- | -- |
| Rwanda | -- | -- | -- | -- | -- | -- | -- | -- |
| Senegal | -- | -- | -- | 2 e/ | 1,800 | -- | -- | -- |
| Sierra Leone | -- | -- | -- | -- | -- | -- | -- | -- |
| Somalia | -- | -- | -- | -- | -- | -- | -- | -- |
| South Africa | 30,830 | 88,613 | 3,240 | -- | 3,077 5/ | 7,968 5/ | 1,706 | 76,853 |
| Sudan | -- | -- | -- | 4,380 | -- | -- | -- | -- |
| Swaziland | -- | -- | -- | -- | -- | -- | -- | -- |
| Tanzania | -- | -- | -- | -- | 3 | -- | -- | -- |
| Togo | -- | -- | -- | -- | 2,731 5/ | -- | -- | -- |
| Tunisia | 238 | 4,764 | -- | 32,229 | 7,167 5/ | 187 5/ | -- | 31,920 |
| Uganda | 200 5/ | -- | -- | -- | -- | 55 | -- | -- |
| Zaire | -- | -- | -- | 10,000 | -- | -- | -- | -- |
| Zambia | -- | -- | -- | -- | -- | -- | -- | -- |
| Zimbabwe | 324 | -- | -- | -- | 123 5/ | 212 5/ | -- | -- |
| Total, Africa 6/ | 48,309 | 184,915 | 6,152 | 2,654,076 | 38,406 | 11,719 | 8,376 | 228,302 |
| Total, world | 1,020,266 | 2,919,775 | 22,264 | 23,379,710 | 132,750 | 758,070 | 41,510 | 7,444,303 |
| Share of world total | 5% | 6% | 28% | 11% | 29% | 2% | 20% | 3% |
| United States | 62,073 | 435,945 | -- | 2,359,725 | 45,400 | 94,651 5/ | 2,854 | 628,063 |

e/ Estimated. p/ Preliminary.

1/ Table prepared by Glenn J. Wallace.

2/ Data may be different from that appearing in individual country production tables owing to availability of more current data. Table includes data available through Mar. 31, 1998.

3/ Source: International Energy Annual 1996, Feb. 1998.

4/ Excluding synthetic diamond.

5/ Reported figure.

6/ May not add to totals shown because of independent rounding.

7/ Includes Puerto Rico data.

8/ Includes lease condensate.

9/ Source: The Uranium Institute 1998, London, Jan. 22, 1998, via the Internet.

Source: U.S. Geological Survey.

# THE MINERAL INDUSTRY OF

# ALGERIA

## By Bernadette Michalski

Hydrocarbons remained by far the leading mineral sector, providing $12.6 billion[1] in export earnings in 1996. The nation also sustained a modest production of metals and industrial minerals. Local parastatal mining companies and agencies were amalgamated into the Office de Recherche Géologique et Minière (ORGM) with the objective of centralizing the promotion of international investment in the Algerian mineral industry. Working with local and international companies, ORGM is responsible for information distribution relating to the mining sector, as well as for the publication of geological maps and the evluation and development of deposits. ORGM has identified several exploitable mineral deposits; their location is, however, in remore areas devoid of any infrastructure.

The Government continued to focus priorities on the following: expanding exploration activities, improving the recovery rate of oil and gas, augmenting hydrocarbon reserves, and increasing hydrocarbon production, transport, and export capacities. The Government offered foreign companies minority equity interest in producing fields, an area from which they had been excluded. A production-sharing agreement with Atlantic Richfield Co. of the United States (ARCO) is Algeria's first association with a foreign partner in exploiting a producing field, the Rhourde El Baquel. ARCO is to receive as much as 49% of the field's output. The field's current production is 25,000 barrels per day (bbl/d). With ARCO's use of in-fill drilling and miscible gas injection technology, the field is expected to reach peak production of 125,000 bbl/d after the turn of the century.

The decree of April 6, 1996, covered the following stipulations relating to foreign company participation in the hydrocarbon industry. A foreign company is no longer required to form a commercial company subject to Algerian law with its head office in Algiers if it sets up a joint stock company with the Government's Société Nationale pour la Recherche, la Production, le Transport, la Transformation, et la Commercialisation des Hydrocarbures (SONATRACH). If a field has not yet been developed or is under development, then the foreign company is required to pay a bonus to access known reserves. If a foreign company finances a pipeline, then priority will be given to transporting hydrocarbons from the field operated by that company. The foreign partners of SONATRACH have the right to use the proceeds of gas exports covered by joint marketing agreements with SONATRACH. The foreign partners are not required to return their share of proceeds from these sales to Algeria.

Crude oil production was 812,000 bbl/d compared with 767,000 bbl/d in 1995. Lease condensates were produced at an average of 430,000 bbl/d compared with 390,000 bbl/d in 1995. The production of natural gas plant liquids averaged 145,000 bbl/d in both years (Energy Information Administration, 1997). A variety of nonfuel minerals were produced in minor amounts; but only iron ore, mercury, and phosphate rock were produced in significant amounts. *(See table 1.)* The entire output of iron ore was consumed by the domestic iron and steel industry. Phosphate rock and mercury was produced entirely for export. Although the Algerian production of mercury has fluctuated widely with the price of this commodity in the world market, the 1995 production was reduced because of technical difficulties.

Natural gas and liquid fuels accounted for about 98% of Algeria's export earnings. The increase in export volumes and oil prices contributed to increased earnings in 1996. Hydrocarbon exports were valued at $12.6 billion compared with $9.6 billion in 1995 (Arab Petroleum Research Center, 1997, p. 18). Other exports were, by order of value, metals and metal products, phosphates, and iron ore. In 1995, exports of helium and nitrogen began with Europe as the principal market for helium and north African countries as the principal markets for liquid and gaseous nitrogen; both types of nitrogen were also marketed domestically (Arab Petroleum Research Center, 1997, p. 45 ).

In 1996, nearly 275 million barrels (Mbbl) of Algerian crude oil and refined products was exported to Western Europe and 95 Mbbl, to the United States. Exports of natural gas totaled nearly 40.8 billion cubic meters in 1996 compared with 37.7 billion cubic meters in 1995. Natural gas exports via pipeline totaled 21.22 billion cubic meters exceeding liquefied natural gas (LNG) exports, which totaled 19.55 billion cubic meters. Italy continued to be the principal market for Algerian natural gas, importing 18.9 billion cubic meters, followed by France at nearly 7.6 billion cubic meters; Spain, 4.8 billion cubic meters; Belgium, nearly 4 billion cubic meters; Turkey, 2.2 billion cubic meters and Slovenia, Tunisia, and the United States, 1 billion cubic meters or less each. Algeria's share of the European gas market ranks third behind the Netherlands with 26% and Russia with 36% (Arab Petroleum Research Center, 1997, p. 45).

Studies conducted by Entreprise d'Exploitation des Mines d'Or (ENOR) show gold deposits at a grade of as much as 25.1 grams per ton. ENOR is looking for international expertise and capital to develop prospects in five geological provinces in the Hogar ragion. The nation's political climate was the major cause of the decision of Anglo American Corp., JCI Ltd., and Gencor Ltd.—all of South Africa—to abandon interest in the pursuit of Algeria's gold potential.

The bulk of Algeria's iron ore output was extracted from the mine at Ouenza. Mining operations were spread over 17 square kilometers, with the main seam 2 kilometers (km) long and 500 meters wide. Iron ore also was mined at Bou Khadra and shipped with Ouenza ore by rail to the El Hadjar processing plant, near Bejaia, a distance of 170 km. Both mines were operated by Entreprise Nationale de Fer et de Phosphates.

---

[1] Where necessary, values have been converted from Algerian dinars (AD) to U.S. dollars at the rate of AD58.04=US$1.00 in 1996.

Helium is produced at the Helios Co.'s Bethious plant, near Arzew. SONATRACH owns a 51% equity in the company, and Air Products & Chemicals, Inc., of the United States and L'Air Liquide of France share the remaining equity. The plant's capacity is 16 million cubic meters per year of liquid helium, accounting for 20% of world output and 33,000 metric tons per year of liquid and gaseous nitrogen (Arab Petroleum Research Center, 1997, p.55).

Anadarko Petroleum Corp. of the United States (Anadarko) discovered oil and gas at its HBNS 3 delineation well at the Hassi Berkine South Fields. The oil is of 42° API gravity. Partners in the concession are Lasmo of the United Kingdom and Maersk Oil & Gas of Denmark.

Gross production of natural gas was 143 billion cubic meters, about 50% of which was reinjected to maintain petroleum-reservoir pressure. The combined total production of LNG at the three liquefaction plants at Arzew and the one at Skikda was about 85,000 cubic meters per day of LNG (Secretariate of the Organization of Petroleum Exporting Countries, 1996).

Most of Algeria's crude oil production was derived from the Hassi Messaoud-Haoud el Hamra Fields in the Sahara; the Zarzaitine-Edjeleh Field near Ohanet; and the In Amenas Field, near the Libyan border. In the near future, increased output will be largely derived from additional production from the Rhourde el-Baguel Field as a result of ARCO's efforts and the development of the Hassi Berkine and the Berkine East Fields by Anadarko. The Hassi Berkine North-1 well flowed at 15,000 bbl/d of 41° API crude oil. Other field activities include a new discovery announced by Agip in April 1996 in block 403. Petro-Canada announced that the Tamadanet Field came on stream in mid-1996 at 12,500 bbl/d. Cepsa of Spain brought the Rhourde El Khrouf Field into production at about 20,000 bbl/d of 51° API crude oil and condensate at the close of 1996 (Arab Petroleum Research Center, 1997, p. 33-37).

Petroleum-refining capacity has been stabilized since the early 1980's when the 325,000-bbl/d-capacity Skikda refinery and the 6,500-bbl/d-capacity In Amenas refinery came on-stream, elevating national refining capacity to 474,500 bbl/d.

Hydrocarbon reserves in January 1997 were 5.1 trillion cubic meters of natural gas. Unassociated natural gas accounted for 85% of these reserves. Recoverable petroleum reserves were 9.98 billion barrels. Iron ore reserves were 35 million metric tons (Mt) averaging 53% iron; an estimated additional resource of 970 Mt grading 53% iron was, however, identified at the undeveloped Gara Djebilit deposit.

Algeria's railroad system, which totaled 4,060 km of track, and its road network, which covered more than 90,000 km, were in the northern section of the country and supported long-established mining and other export-oriented industries. The existing infrastructure was too distant to lend support to the development of commercial mineral deposits reported in the southern desert.

More than 11,400 km of pipeline served the hydrocarbon industries within Algeria. The center of the crude oil pipeline network was Hassi Messaoud, in the southeast, from which three crude pipelines ran north to Skikda, Bejaia, and Arzew. The center for the natural gas pipeline network was Hassi R'Mel, with pipelines connecting to liquefaction facilities at Arzew and Skikda. Hassi R'Mel was also the source for natural gas exports to southern Europe by means of the 4-billion-cubic meter-capacity Trans-Mediterranean pipeline and the 8-billion-cubic meter-capacity Maghreb-Europe pipeline. The Transmed natural gas export pipeline extended for 2,340 km from Algeria northeastward through Tunisia and under the Mediterranean Sea to Sicily and the Italian mainland. Natural gas was exported to Slovenia by means of a 35-km spur line near the Italian end of the Trans-Mediterranean pipeline. The 1,845-km Maghreb-Europe pipeline was under construction traversing Algeria northwestward through Morocco and the Straits of Gibraltar to Seville, Spain. The pipeline was inaugurated in November 1996 at an initial capacity of 8 billion cubic meters per year. The second phase of the Maghreb-Europe pipeline construction will include extensions to Portugal, France, and Germany. Additional compressor stations could bring the pipeline capacity to 18 billion cubic meters per year, if commercial outlets warrant it.

Algeria used seven marine terminals for the export of hydrocarbons, including La Skhirra, in Tunisia. The largest terminal was Arzew-Bethioua, which accommodated 40% of all hydrocarbon exports. Port capacity at Skikda was limited to 90,000-cubic meter LNG carriers. Efforts were underway to augment facilities to permit the accommodation of 125,000-cubic meter LNG carriers.

Stimulating foreign investment interest in Algeria's aging energy industries was vital to the economy because the nation did not have enough cash or access to sufficient credit to sustain economic activity. In pursuing this course of action, the Algerian Government has not only encouraged exploration agreements, but has offered a portion of production rights in existing oil fields and gas fields to private companies with capital and enhanced recovery capabilities. This action represented the most significant change in oil policy since nationalization in 1971. ARCO, Agip, Anadarko, British Petroleum, Cepsa, Petro-Canada, Repsol, and Total SA were among those under contract with SONATRACH. Without foreign capital to refurbish the hydrocarbon extraction and processing facilities, as well as the supporting transport infrastructure, Algeria may be unable to satisfy demand within a few years. The World Bank extended a $150-million economic rehabilitation support loan. Specific reform requirements of the World Bank include the following: preparing legislation for privatization, selling public enterprises, and restructuring major public enterprises such as the steel and fertilizer industries.

In the hydrocarbon sector, financing difficulties have delayed some oil and gas projects. SONATRACH is pursuing a policy of simultaneous upstream capacity expansion in oil, natural gas, and gas liquids production.

With an accumulated external debt of $33.5 billion, any decline in oil prices has serious implications for the Government's domestic finances. Since 1994, the recovery of global oil prices has, however, brought improved export earnings and, consequently, an improved environment for international debt rescheduling. The spot price for Algeria's Saharan Blend crude oil was 22% higher, at an average of $21.27 per barrel, compared with an average of $17.42 per barrel in 1995.

In future years, recoverable reserves should increase as a result of new discoveries, improved data on existing fields, and the installation of enhanced recovery systems. Seven promising hydrocarbon discoveries were reported in 1996. Although the delineation and appraisal work was not fully completed, preliminary data indicate that most of the discoveries should, in all probability, be pronounced commercial.

## References Cited

Arab Petroleum Rsearch Center, 1997, Arab oil and gas directory—Algeria: Paris, Arab Petroleum Research Center, 39 p.

Energy Information Administration, 1997, International petroleum statistics report: Energy Information Agency, DOE/EIA-0520 (9706), p. 4, 7-8.

Secretariat of the Organization of Petroleum Exporting Countries, 1996, Annual statistical bulletin: Vienna, Organization of Petroleum Exporting Countries, p. 16.

## Major Sources of Information

Office de Recherche Géologique et Minière (ORGM)
B.P. 102
Boumerdes, Algeria
Telephone: 213-2-824060
Fax: 213-2-820379
Ministry of Mines
80 Avenue Ahmed Ghermoul
Algiers, Algeria
Ministry of Industry
Le Colise Rue Ahmed-Bey de Constantine
Algiers, Algeria
Société Nationale des Matériaux de Construction
90 Rue Didouche Mourad
Algiers, Algeria
Société Nationale pour la Recherche, la Production, le Transport, la Transformation, et la Commercialisation des fHydrocarbures
10 Rue du Sahara, Hydra
Algiers, Algeria
Société Nationale de Siderurgie
Ravin Sidi Yahia
Boite Postale 54
Hydra, Algeria
Telephone: 213-8-830999
Fax: 213-8-843020
Entreprise Nationale de Sel (ENASEL)
127 Boulevard Salah Backer
Algiers, Algeria
Telephone: 213-2-946767

## TABLE 1
## ALGERIA: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

| Commodity 2/ | | 1992 | 1993 | 1994 | 1995 | 1996 e/ |
|---|---|---|---|---|---|---|
| METALS | | | | | | |
| Cadmium, refined e/ | | 75 | 75 | 75 | 75 | 75 |
| Iron and steel: | | | | | | |
| Iron ore, gross weight | thousand tons | 2,523 | 2,311 | 2,047 | 2,200 | 2,245 3/ |
| Metal: | | | | | | |
| Pig iron | do. | 930 | 925 | 919 | 940 | 800 |
| Steel, crude | do. | 842 | 865 | 808 | 827 | 620 3/ |
| Lead: | | | | | | |
| Concentrate, Pb content | | 920 | 1,538 | 1,100 r/ | 1,383 | 1,016 3/ |
| Metal, refined | | 4,500 | 6,000 | 8,000 | 8,000 | 8,000 |
| Mercury | kilograms | 476,000 | 459,100 | 414,000 | 292,000 | 367,800 3/ |
| Silver e/ | do. | 1,900 | 2,200 | 3,000 | 3,000 | 3,000 |
| Zinc: | | | | | | |
| Concentrate, Zn content | | 7,500 | 6,800 | 5,700 r/ | 7,174 | 5,912 3/ |
| Metal, smelter output | | 31,500 | 33,400 | 30,000 | 30,000 | 25,000 |
| INDUSTRIAL MINERALS | | | | | | |
| Barite: Crude | | 51,159 | 47,232 | 20,584 | 29,838 | 31,348 3/ |
| Cement: Hydraulic | | 6,400 | 6,400 | 6,060 | 6,200 | 6,500 |
| Clays: | | | | | | |
| Bentonite | | 31,019 | 20,833 | 20,215 | 17,088 | 17,200 |
| Fuller's earth | | 3,656 | 3,229 | 4,550 | 4,500 | 4,500 |
| Kaolin | | 20,844 | 12,586 | 16,984 | 24,068 | 25,000 |
| Diatomite | | 2,671 | 3,471 | 2,800 r/ | 3,700 | 3,700 |
| Feldspar | | 4,700 | 6,500 | 6,900 | 7,000 | 7,000 |
| Gypsum 4/ | thousand tons | 355 | 225 | 225 | 250 | 250 |
| Helium, liquid | million cubic meters | -- | -- | -- | 10 | 15 |
| Lime, hydraulic e/ | | 62,000 | 62,000 | 62,000 | 62,000 | 62,000 |
| Nitrogen, N content of ammonia | | 438,000 | 380,000 | 380,000 | 400,000 | 425,000 |
| Phosphate rock: | | | | | | |
| Gross weight | thousand tons | 1,136 | 718 | 730 | 1,596 | 1,051 3/ |
| P2O5 content | do. | 389 | 245 | 251 | 500 | 320 |
| Salt: Brine and sea salt | | 180,000 | 179,000 | 178,000 | 178,000 | 178,000 |
| Sodium compounds, caustic soda e/ | | 700 | 700 | 700 | 700 | 700 |
| Strontium minerals, celestite, gross weight e/ | | 5,400 | 5,400 | 5,400 | 5,400 | 5,400 |
| Sulfur, elemental e/ | | 20,000 | 20,000 | 20,000 | 20,000 | 23,000 |
| MINERAL FUELS AND RELATED MATERIALS | | | | | | |
| Gas, natural: | | | | | | |
| Gross | million cubic meters | 128,000 | 133,700 | 131,100 | 114,779 r/ | 143,100 3/ |
| Dry 5/ | do. | 53,200 | 53,900 | 51,100 | 58,100 | 62,300 3/ |
| Natural gas plant liquids | thousand 42-gallon barrels | 52,855 | 52,925 | 51,500 | 53,000 | 53,000 |
| Petroleum: | | | | | | |
| Crude including condensate | do. | 443,110 | 424,130 | 430,700 | 436,905 | 453,300 3/ |
| Refinery products: | | | | | | |
| Liquefied petroleum gas | do. | 10,000 | 9,000 | 9,500 | 10,000 r/ | 10,000 |
| Gasoline | do. | 19,272 | 20,988 | 18,900 e/ | 21,900 r/ | 21,900 |
| Naphtha e/ | do. | 30,000 | 30,000 | 31,000 | 31,000 | 31,000 |
| Kerosene | do. | 3,869 | 3,723 | 8,540 r/ | 8,030 r/ | 8,100 |
| Distillate fuel oil | do. | 57,378 | 54,530 | 49,800 r/ | 51,976 r/ | 52,000 |
| Lubricants | do. | 825 | 800 | 825 e/ | 850 r/ | 850 |
| Residual fuel oil | do. | 37,630 | 37,700 | 37,400 e/ | 36,646 r/ | 36,800 |
| Other e/ | do. | 2,900 | 2,700 | 3,000 r/ | 3,500 | 3,500 |
| Total | do. | 161,874 | 159,441 | 158,965 r/ | 163,902 r/ | 164,150 |

e/ Estimated. r/ Revised.

1/ Table includes data available through July 1, 1997.

2/ In addition to the commodities listed, secondary aluminum, secondary lead, and secondary copper may be produced in small quantities, and crude materials are produced for local consumption. Output is not reported, and available information is inadequate to make estimates of production levels.

3/ Reported figure.

4/ Includes about 50,000 tons of plaster each year.

5/ Excludes gas used in reinjection, flaring, venting, transmission losses, and natural gas liquids extraction.

## THE MINERAL INDUSTRY OF

# ANGOLA

### By George J. Coakley

Angola has a population of about 10.5 million in a 1,246,700 square kilometers (km$^2$) area, which includes Cabinda, a 100-kilometers (km) wide and 150-km deep coastal strip located between Congo-Brazzaville and Zaire. Cabinda is the source of about 50% of Angola's oil production. The mineral economy of Angola is dominated by petroleum with a significant contribution from diamond production *(See table 1)*. Angola's gross domestic product (GDP) was $8.31 billion by yearend 1996, with petroleum and related services accounting for about 50% of GDP. Following over 20 years of fighting, the country's lengthy civil war appeared to be resolved. During 1996, the Government began to rebuild a shattered economy and to attract foreign investment back to the minerals sector. Favorable exploration results from offshore drilling in 1996 and early 1997 indicated considerable potential for significantly expanding Angola's petroleum production over current levels of about 710,000 barrels of crude oil per day. International oil companies operated in joint ventures or under production-sharing agreements with the Government's Sociedade Nacional de Combustiveis de Angola (Sonangol). Chevron of the United States and the French company, Le Group Elf Aquitane, were the major petroleum operators.

The diamond producing areas, previously controlled by the opposition forces of the National Union for the Total Independence of Angola (UNITA), in Lunda Norte and Lunda Sul Provinces accounted for about $400 million out of Angola's annual national diamond output of $1.1 billion and were opened to outside exploration and development companies in 1996. The state-owned diamond mining company, Empressa Nacional de Diamantes de Angola (Endiama), issued exploration licenses or entered joint ventures for a number of projects. De Beers, after a 10-year absence from Angola, acquired a 5-year exploration right to examine the alluvial and kimberlite diamond potential in Cuando-Cubango Province. Endiama entered a joint venture with Sociedade Portuguesa de Emprendimentos in Sociedade Mineira de Lucapa's 8,000 km$^2$ concession in the Camfue and Camiambo areas of Lunda Norte. Endiama also entered a joint venture with Brazil's Oderbrecht Mining Services and Russia's Almay Rossii-Sakha to begin production by late 1996 of over 900,000 carats annually from the Sociedad Mineira de Catoca's kimberlite holdings in Lunda Sol Province. American Mineral Fields acquired a 50% interest in a 3,700 km$^2$ diamond concession held by a Dutch West Indies security firm, International Defense and Security Forces, on the Luremo River near the border with Zaire. The Canadian company, Carson Gold Corporation, and its subsidiary, Branch Energy Ltd., acquired majority interest in reported resources of over 10 million carats of diamond in the Luo and Luarica concessions in Lunda Norte Province (DiamondWorks Ltd., 1996). Carson Gold was acquired by DiamondWorks Ltd. of Canada in 1997. SouthernEra Resources Ltd. of Canada entered an agreement with Sphere Trading Ltd. in September 1996 to cooperate in exploration and development of four alluvial diamond concession areas. Sphere mined 48,000 carats averaging over $99 per carat from the area in 1996. For payment of $2.5 million, SouthernEra obtains rights to 35% of profits from properties it operates and 10% of net profits from Sphere operations in return for technical expertise and financing (SouthernEra Resources Ltd., 1996).

### References Cited

DiamondWorks Ltd., 1996, Carson to become world player in diamond industry—Carson acquires major diamond concessions in Africa: DiamondWorks Ltd. (formerly Carson Gold Corp.) press release, June 27, 4 p. (Accessed February 3, 1997, on the World Wide Web at URL http://www.info-mine.com/press_releases/dmw/pr062796dmw.html or currently at http:www.diamondworks.com/press.html)

SouthernEra Resources Ltd., 1996, SouthernEra to participate immediately in mining of alluvial diamonds in Angola: Southern Era Resources Ltd. press release, September 25, 1 p. (Accessed October 16, 1996, on the World Wide Web at URL http://www.southernera.com/pr960925.htm)

### Major Source of Information

Ministry of Geology and Mines
P.O. Box 1260
Luanda, Angola
Telephone: (244-2) 326-724; Fax: (244-2) 321-655

## TABLE 1
## ANGOLA: PRODUCTION OF MINERAL COMMODITIES 1/

| Commodity | | 1992 | 1993 | 1994 | 1995 e/ | 1996 e/ |
|---|---|---|---|---|---|---|
| Cement, hydraulic e/ | thousand metric tons | 260 | 250 | 300 | 300 | 300 |
| Diamond 2/ 3/ | thousand carats | 1,180 | 1,000 | 1,400 | 2,900 | 2,500 4/ |
| Gas, natural: e/ | | | | | | |
| Gross 5/ | million cubic meters | 5,600 | 5,600 | 5,600 | 5,210 r/ 4/ | 5,600 |
| Dry | do. | 564 4/ | 560 | 560 | 560 | 560 |
| Granite | thousand cubic meters | 184 | 1,130 | 1,490 e/ | 1,500 | 1,500 |
| Marble | do. | 455 | 104 | 91 | 100 | 100 |
| Petroleum: | | | | | | |
| Crude | thousand 42-gallon barrels | 190,000 | 182,865 | 196,370 | 232,800 4/ | 259,150 4/ |
| Refinery products e/ 6/ | do. | 10,200 | 9,000 | 9,000 | 10,585 4/ | 11,000 |
| Salt | metric tons | 30,000 r/ | 40,000 r/ | 40,000 r/ | 40,000 r/ | 40,000 |

e/ Estimated. r/ Revised.

1/ Includes data available through December 1997.

2/ Does not include smuggled production.

3/ Production is approximately 90% gem and 10% industrial grade.

4/ Reported figure.

5/ Angola has no natural gas distribution system. Most gas is vented and flared.

6/ Includes asphalt and bitumen.

## THE MINERAL INDUSTRY OF

# BOTSWANA

### By Henry E. Hilliard

Botswana's rapid economic growth, which began in the 1970's, continued into 1996. This growth can be attributed to Botswana's successful program of mineral exploration and development. In 1995-96 the mineral industry provided about 80% of the value of national exports, as well as about 50% of Government revenue. Historically, the economy in Botswana has been based on cattle raising and crops. Agriculture today provides a livelihood for more than 80% of the population but supplies only about 50% of food needs and accounts for only 5% of gross domestic product (GDP). The mineral industry was the principal reason the country had a high per capita GDP and a surplus in balance of payments. The mining sector, mostly on the strength of diamonds, accounted for about 33% of the GDP, which was approximately \$4.9 billion[1] in 1995-96. Nickel and copper also played significant, though smaller, roles in the national economy. Other valuable minerals produced included agate, clay, coal, cobalt, gold, salt, sand, silver, soda ash, and stone. Diamond was the most notable target of exploration during 1996. Despite the potential for new diamond mines, the Government of Botswana is seeking to expand into other metals and minerals. According to the Botswana Geological Survey, the potential for the discovery of platinum-group metals in Botswana is good, owing to the likely extension of the Bushveld complex in South Africa into the southern part of Botswana. However, much of Botswana's mineral resources remained unexplored, buried under the sands of Kalahari Desert that covers much of the country.

The current Government's objective is to become less dependent on mining and cattle ranching and concentrate on the development and processing of its raw material resources in Botswana rather than shipping them elsewhere for processing. By producing downstream products, the Government expects to increase its export trade. An example is the Botswana Ash (Pty.) Ltd., soda ash project which could stimulate local manufacture of detergents, potash, and fertilizers, while the production of copper and nickel could boost local production of electrical components.

Known mineral deposits in Botswana include asbestos, chromite, feldspar, graphite, gypsum, iron, kaolin, talc, and uranium. Also, Botswana has large proven resources of bituminous coal which have not yet been fully exploited.

## Government Policies and Programs

In an effort to convert its diamond wealth into jobs and economic growth, the Government of Botswana was in the process of creating an advanced infrastructure with good roads, communications, and dependable utilities. To encourage investment, it lowered corporate taxes from 35% to 25%. Manufacturing firms had their taxes lowered from 35% to 15%. And, either directly or through parastatals, the Government has invested heavily in foreign and domestic partnerships.

Botswana is a member of the Southern African Customs Union (SACU), which unites Lesotho, Namibia, South Africa, and Swaziland in a customs-free zone. With the exception of certain foodstuffs, import permits are not required for goods entering Botswana from the Common Customs area. SACU applies a common external tariff against goods entering from outside the Customs Union. Exports from Botswana generally do not require permits with the exception of radioactive materials, unpolished diamonds, gold, and some agricultural products.

In 1996, the Government encouraged foreign investment in Botswana. There were no restrictions on reinvestment or repatriation of earnings and capital. Botswana has never nationalized or expropriated any foreign business. It carefully followed its established rules for investment, and its courts repeatedly upheld contracts.

The Ministry of Mineral Resources and Water Affairs had responsibility for the mining sector. The Ministry granted reconnaissance permits (for 1-year general prospecting) and prospecting licenses (for 3 years plus two 2-year extensions with minerals and area specified). It negotiated 25-year mining leases with project plans, financial aspects, and lease extension conditions specified. Subunits of the Ministry also carried out geologic surveys and made mine safety and environmental inspections and collected mineral production information. The Ministry's Department of Mines maintained a register of mineral investment opportunities.

In 1996, the Government of Botswana began legislative initiatives that will make investment in new mining developments more attractive. Amendments to existing mineral statutes are expected to be approved by parliament in the latter part of 1997. If approved, the legislation will allow prospecting license holders to retain rights to a deposit for up to 2 years after expiration where immediate development of a mining operation is impractical. Licensees would also be granted guaranteed mining rights, provided they have the necessary technical and financial capability, and submit an acceptable mining plan. Most exploration currently takes place under a 3-year prospecting license covering a maximum 1,000 square kilometers, which may be renewed twice for 2-year periods with 50% of the area relinquished each time. In 1996, there were 500 valid exploration licences on issue, most for precious stones. Under the proposed legislation, retention rights would be valid for up to 3 years, renewable once for the same period, and would be issued if no third party offered to mine the area in the meantime. The Government's current entitlement to 15% to 25% free carried interest in any mining project would be replaced by a 15% working interest. Some changes in the fiscal regime are under consideration. The tax rate for small mines has already been reduced to 25%. The proposed changes are designed to increase the security of tenure for investors by removing ministerial discretion, make the progression from prospecting to mining easier, and incorporate modern principles of administrative law.

---

[1] **Where necessary, values have been converted from Botswana Pula (P) to U.S. dollars at the rate of P2.98=US\$1.00 for 1996.**

### Environmental Issues

Air pollution and abatement programs were continued in 1996. The Department of Mines' air pollution monitoring stations, deployed throughout the country, were designed to measure sulfur dioxide and total suspended particulates. Three newer stations located at Tonota, Serowe, and Gaborone also measure carbon monoxide, nitrogen oxides, ozone, and hydrocarbons using automatic gas analyzers. Ambient air quality monitoring activities were concentrated in the Selebi-Phikwe area where government air pollution sampling instruments, supported by BCL Ltd.'s, air pollution program, measured the effects of emissions from the copper-nickel smelter. All eight air pollution monitoring stations in the residential area of Selebi-Phikwe recorded annual mean sulfur dioxide concentrations within the Government guideline of 80 micrograms per cubic meter (Republic of Botswana Department of Mines, 1997a).

The Department of Mines continued with a study to address the emissions of greenhouse gases and global warming in collaboration with the Department of Meteorological Services. This project was part of Botswana's response to the United Nations Framework Convention on Climate Change. A draft report titled "Inventory of Emissions by Source and Removal by Sinks of Greenhouse Gases in Botswana" was completed in May 1996. A final report was scheduled to be produced after the second Botswana Climate Change Conference to be held in March 1997 (Republic of Botswana Department of Mines, 1997b).

### Production

Diamonds, copper-nickel-cobalt concentrates, soda ash, coal, and gold were produced in Botswana. The country is Africa's largest and the world's third largest producer of diamonds and second largest producer of gem diamonds. Diamond mining is dominated by Debswana Diamond Co. (Pty.) Ltd., with a total mine output of 17.7 million carats in 1996.

BCL Ltd. milled 3.4 million tons of ore at the Selebi-Phikwe base metal operation, producing 38,800 tons of copper-nickel-cobalt concentrate. This was an increase of 2% over production in 1995. Tati Nickel Mining Co. (Pty.) Ltd. produced an additional 19,150 tons of concentrate for a total of 57,950. The concentrate contained 23,300 tons of copper, 22,900 tons of nickel, and 400 tons of cobalt. Other metals and minerals produced in Botswana include gold (4.5 kilograms), soda ash (119,137 tons), and salt (93,886 tons).

### Trade

Botswana offers a limited market for trade owing to its small population of 1.49 million and GDP of only $4.9 billion. Botswana's major imports in terms of value for 1996 were fuels, articles of iron and steel, heavy machinery and mechanical appliances, electrical machinery, and vehicles. All petroleum refinery products are imported form from neighboring South Africa. Major end-users of off-highway vehicles were the mining and construction sectors. Both sectors continue to perform well, and mining was expected to expand again in fiscal year 1996-97. Growth in these sectors has resulted in increased demand for off-highway trucks. All heavy equipment and machinery were imported as there was no local production or assembly.

In 1996, mineral commodities continued to dominate the country's exports, with Europe being the principal destination. More than 70% of total export value of $2.1 billion was attributed to diamond shipments in 1996. Cobalt, copper, and nickel content of smelter matte and soda ash contributed about 10% of total export value.

Botswana's motor industry was the second largest net foreign exchange earner after minerals. The Korean automotive manufacturer, Hyundai Motor Distributors, assembled 2,000 vehicles per month in semi-knocked down form mainly for export to neighboring South Africa. It added 250 components in Botswana to qualify for duty-free export to South Africa. Hyundai was the country's largest industrial exporter in 1996, employing 425 people.

### Structure of the Minerals Industry

The Government and Anglo American Corp. of South Africa Ltd. (AAC) were significant partners in Botswana's mineral industry. *(See table 2.)* De Beers Centenary AG, an AAC-affiliated company, owned one-half of Debswana Diamond Co. (Pty.) Ltd. AAC had an equity interest in Botswana RST Ltd. which was the Government's partner in BCL, the nickel-copper-cobalt producer. AAC holdings also included substantial interests in Tati Nickel Mining Co. (Pty.) Ltd., (TNMC) and Morupule Colliery (Pty.) Ltd. Besides the BCL, Debswana, and Botswana Ash operations, the Botswana industry consisted of a number of medium- and small-scale mines producing agate, aggregates, brick making clay, gold, and dimension stone.

Employment in the domestic mining industry was about 13,000 employees, slightly more than 5% of a total formal (wage-earning) employment of about 250,000. Major mines, such as the BCL and Botswana Ash operations, were situated in regions with few job opportunities. This, coupled with the state's ownership interest in the companies, resulted in the Government's active support of the operations.

### Commodity Review

#### *Metals*

**Cobalt, Copper, and Nickel.**—Selebi-Phikwe is the center of Botswana's copper-nickel-cobalt mining industry. The industry is dominated by BCL, one of the largest private sector employers with over 4,800 employees. About 40,000 tons per year of copper-nickel matte was produced for refining in Norway and Zimbabwe. The Selebi-Phikwe operation, which produces about 2% of the world supply of nickel, is a complex with three underground mines equipped with modern technology for flash smelting and the production of high-grade matte. The company has struggled for much of its existence against the volatility of international metal prices. Production of copper-nickel concentrates by TNMC for toll-smelting by BCL was expanded following commissioning of the open pit Phoenix mine in early 1995. Minable reserves at Phoenix were upgraded by TNMC to 15.2 million tons at a grade of 0.65% nickel and 0.31% copper. TNMC applied for assistance to help fund further exploration at depth during 1997. During 1996, BCL agreed to increase its treatment contract for TNMC concentrates by 20,000 tons per year to 160,000 tons per year.

**Gold.**—Gold production was predominantly from the Monarch Mine, with some production provided by Minerals Holdings Botswana (Pty.) Ltd.'s tailings dump retreatment and Kudu Mining Co. (Pty.) Ltd.'s Rainbow Mine. Southern Africa Joint Venture, a consortium of Australian companies, began test mining of the oxide ore of the Golden Eagle open pit in February 1995 and was reprocessing tailings from the Map Nora Mine, which Phelps Dodge Mining Co. of the United States had operated from 1989 to 1991.

Production of gold bullion in Botswana decreased from 86 kilograms in 1995 to 4.5 kilograms in 1996. Suspension of operations at Monarch Mine in 1995 and serious shortage of water supply at the other small mining operations contributed to the sharp decline in gold production. The reopening of Monarch Goldfields' Golden Eagle Mine in October 1996 provided some hope of sustained gold production in the Francistown area. Also, Sigmor Mines (Pty.) Ltd. made preparations to develop its Signal Hill gold deposit located 55 kilometers southeast of Francistown. The deposit was discovered in the late 1980's but economic conditions have, until now, precluded the mining of the deposit. Sigmor Mines planned to extract the ore through open pit mining methods and heapleach the ore to recover gold. Production startup was expected during the second half of 1997.

### *Industrial Minerals*

**Diamonds.**—De Beers Prospecting Botswana (Pty.) Ltd. continued its countrywide prospecting. It processed samples from prospects in the Gope area in conjunction with Falconbridge of Canada. Debswana increased the processing capacity at the Jwaneng Mine with the addition of a fourth treatment line. Output from Jwaneng, Orapa, and Letlhakane mines was 11.166 million, 5.644 million and 0.897 million carats respectively. De Beers planned to increase production at its Orapa Mine, lifting output to more than 11.5 million carats per year by 2000, at a cost of $290 million (Northern Miner, 1996).

A number of international mining companies were actively exploring for diamonds. AfriOre Ltd. of Canada, formerly Amarado Resources Ltd., was involved in a joint venture on the Kokong West property operated by a local subsidiary of Gencore of South Africa. BHP Minerals International Exploration Inc.'s exploration activity was earning BHP 51% interest in AfriOre's Gope diamond prospect. Auridiam Consolidated NL of Australia continued its evaluation of three diamondiferous kimberlite pipes in the Orapa area.

Lazare Kaplan Botswana (Pty.) Ltd. (Lazare Kaplan International Inc. of the United States, 60%; Botswana Development Corp., 34.9%; and Government of Botswana, 5.1%) operated a diamond cutting and polishing plant in Molepolole. The operation, opened in 1993, concentrated on production of smaller stones (less than 0.18 carat).

Five small kimberlites located near Martins Drift in eastern Botswana are to be mined by a new Debswana subsidiary, Tswapong Mining. The Government holds a 15% interest in the company, which was granted a short-term mining lease. Underground bulk sampling and large-diameter drilling programs were completed by Debswana on the two Gope kimberlite pipes in central Botswana held in partnership with Falconbridge of Canada (Mining Journal, 1997).

**Gemstones.**—Masa Precious Stones (Pty.) Ltd. and Agate Botswana (Pty.) Ltd. remained the only two licensed dealers of semiprecious stones in 1996. The former is located in Bobonong and prepares stones for direct export or to supply Agate Botswana, which processed the stones further. Agate Botswana (Pty.)Ltd., located in Pilane, processed both raw materials produced in Botswana plus some imported stones. A total of 35 tons of stones were sold in 1996.

**Soda Ash.**—Botswana Ash (Pty.) Ltd., acquired the assets and business of Soda Ash Botswana (Pty.) Ltd. in October 1995. The Botswana Ash plant, designed to produce 300,000 tons of soda ash per year, is located at Sua Pan, 180 kilometers from Francistown. In early 1996, operations at the plant were suspended following exceptionally heavy rain in the Nata River Basin area. The resulting flood caused a breach in a protective wall separating the Pan and the solar ponds. This resulted in an 11 week suspension of production operations while repairs to the damaged infrastructure were performed. Production resumed during the second quarter of 1996 at a reduced rate, with preflood levels of soda ash production being achieved during the second half of 1996. AAC, one of the shareholders in the project, an adequate stockpile of soda ash enabled the company to meet its sales commitment during the first 2 weeks of the shutdown. In order to maintain deliveries during the remaining 9 weeks of the shutdown, Botash was forced to buy more than 27,000 tons of soda ash from a competitor, American Natural Soda Ash Corporation (U.S. Embassy, 1996).

### *Mineral Fuels*

Morupule Colliery (Pty.) Ltd. was the sole coal producer in Botswana. Coal production continued to be constrained by less than expected demand by major consumers, especially Botswana Ash. The Government of Botswana received inquiries during 1996 from local and foreign companies regarding the potential development of Mmamabula coal reserves. Although no plans were finalized by yearend, some companies were conducting feasibility studies with the possibility of starting up mining operations in the near future.

## Infrastructure

Transportation facilities were good on the eastern fringe of the country. The main routes are served by well maintained tarmacadam roads, including the main north-south route between Ramatlabama and Ramokgwebana, the routes north from Francistown to Maun and Kasane, and across the border near Gaborone to Johannesburg and Pretoria. A Trans-Kgalagadi highway linking Gaborone with the Namabian port of Walvis Bay via Ghanzi and Mmamuno was in the final stage of construction. A single-track railway, operated by Botswana Railways, runs from north to south through the eastern part of the country, linking South African and Zimbabwean networks. Branch lines serve the major mining operations at Morupule, Selebi Phikwe, and Sua Pan. The national airline, Air Botswana, is based at the small but modern Sir Serestse Khama Airport serving Gaborone.

Electric generating capacity consisted of the 132-megawatt (MW) Morupule coal-fired plant and the 60-MW coal-fired plant at Selebi-Phikwe. About two-thirds of the power generated was consumed by the mining industry, most notably BCL and Debswana.

Water is a scarce commodity in Botswana. Urban centers receive a reliable supply of potable water based on surface reservoirs operated by the Water-Utilities Corporation, while rural areas are serviced by the Department of Water Affairs, largely through development of ground water resources. A newly constructed dam at Letsibogo in the northeast will provide a water source to feed a north-south pipeline extending 400 kilometers to the south (Magang, 1997).

## Outlook

Heavy exploration activity was expected to continue in the short term, and this may result in new commercial mineral operations. The country's favorable geologic environment and mineral investment climate should continue to make Botswana a target for foreign mineral investment.

Botswana's long-term economic prospects must be viewed in context of the southern African region. Although Botswana's economy grew at an annual rate of over 10% in the 1980's, even as South Africa's politically isolated economy suffered, Botswana's economic fate is closely intertwined with that of its larger neighbor. Apart from minerals, Botswana's "engines of growth"—manufacturing and assembly for regional export, tourism, and offshore financing are all contingent on the health of the South African economy.

## References Cited

Magang, D.N., 1997, p. 3-4, Address by Honorable D.N. Magang on Botswana: MIGA (World Bank) African Mining Investment and Business Symposium, Denver Colorado, June 3-5, 1997, 10 p.

Mining Journal, 1997, Gem gain for Botswana: Mining Journal, v. 329, no. 8446, September 12, p. 67.

Northern Miner, 1996, De Beers set to expand Orapa diamond mine: Northern Miner, v. 82, no. 26, p. 6.

Republic of Botswana Department of Mines, 1997a, 1996 Annual report: Republic of Botswana Department of Mines, p. 19.

———1997b, 1996 Annual report: Republic of Botswana Department of Mines, p. 21.

U.S. Embassy, Gaborone, Botswana, 1996, Floods stop work at Botswana's soda ash operations: U.S. State Department Cable, R151437 (March 13, 1996), 32 p.

## Major Sources of Information

Ministry of Mineral Resources and Water Affairs
P.O. Box 0018
Gaborone, Botswana
Telephone: (267) 360-4600
Fax: (267) 372-738

Department of Mines
P.O. Box 0049
Gaborone, Botswana
Telephone: (267) 352-641
Fax: (267) 352-141

Department of Geological Survey
P.O. Box 0014
Lobatse, Botswana
Telephone: (267) 330-428
Fax: (267) 332-013

Mbendi, Information Services, Internet address: http://wwwmbendi.co.za/indy/mingbo.htm

## Major Publications

Department of Mines Annual Report. Republic of Botswana, Gaborone, annual.

U.S. Department of State. Country Commercial Guide: American Embassy, Botswana, annual.

## TABLE 1
## BOTSWANA: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

| Commodity 2/ | | 1992 | 1993 | 1994 | 1995 | 1996 |
|---|---|---|---|---|---|---|
| Coal, bituminous | | 901,452 | 890,000 | 900,298 | 898,383 | 763,240 |
| Cobalt: Smelter output, Co content of matte 3/ 4/ | | 208 | 205 | 225 | 270 | 406 |
| Copper: | | | | | | |
| Mine output, Cu content of ore milled | | 24,400 | 25,100 | 27,500 e/ | 24,700 e/ | 28,000 e/ |
| Smelter output, Cu content of matte 3/ 4/ | | 20,413 | 20,132 | 22,780 | 20,500 | 23,299 |
| Diamond: 5/ | thousand carats | 15,946 | 14,730 | 15,550 | 16,802 | 17,707 |
| Gemstones, semiprecious 6/ | | 39 r/ | 40 r/ | 67 | 20 | 35 |
| Gold 7/ | kilograms | 165 | 192 | 234 r/ | 86 8/ | 5 |
| Manganese ore (e/ 45% Mn) 9/ | | 1,318 | 3,700 | -- | -- | -- |
| Nickel: | | | | | | |
| Smelter output, matte, gross weight 3/ | | 48,071 | 50,780 | 51,488 | 49,931 | 58,000 e/ |
| Smelter output, Ni content of matte 4/ | | 18,873 | 21,621 | 19,041 | 18,100 | 22,900 |
| Salt 10/ | | 53,708 | 98,000 | 186,000 | 208,126 | 93,886 |
| Sand, construction 11/ | cubic meters | 190,305 | 150,000 | 140,000 | 112,000 | NA |
| Soda ash, natural | | 123,593 | 126,000 | 174,000 | 201,657 r/ | 119,137 |
| Stone, crushed | cubic meters | 804,242 | 760,000 | 572,000 | 860,737 | 845,526 |

e/ Estimated. r/ Revised. NA Not available.

1/ Table includes data available through May 26, 1997.

2/ In addition to commodities listed, the following were produced, but information was inadequate to reliably estimate output: silver and clay for brick and tile.

3/ Smelter product was granulated nickel-copper-cobalt matte.

4/ Figures also used for recoverable mine output in world production tables appearing in Volume I of the Minerals Yearbook. Included some product from direct smelting ore, i.e., ore not reported as milled.

5/ Assumed to contain about 70% gem and near gem.

6/ Presumably, principally agate. Reported as sales.

7/ Reported as bullion; historically included silver estimated at about 2%.

8/ Monarch Mine placed on care and maintenance during May 1995; reopened in Oct. 1996.

9/ Production commenced in 1992 and ceased in Nov. 1993.

10/ From natural soda ash production.

11/ Additional production of sand and gravel from small local operations was periodically reported, but information was inadequate to reliably estimate output.

## TABLE 2
## BOTSWANA: STRUCTURE OF THE MINERAL INDUSTRY FOR 1996

(Metric tons unless otherwise specified)

| Commodity | | Major operating companies and major equity owners | Location of main facilities | Annual capacity |
|---|---|---|---|---|
| Clay 1/ | | Lobatse Clay Works (Proprietary) Ltd. (Botswana Development Corp./Interkiln Corp. joint venture) | Lobatse, 70 kilometers south-southwest of Gaborone | 50,000 e/ |
| Do. | | Makoro Brick and Tile (Pty.) Ltd. | Makoro, 10 kilometers south of Palapye | 20,000 e/ |
| Coal | | Morupule Colliery (Pty.) Ltd. (Anglo American Corp. of South Africa Ltd. (AAC) and related firms, 93.3%) | Morupule, 270 kilometers north-southwest of Gaborone | 1,000,000 |
| Cobalt 2/ | | BCL Ltd., (Government, 30%; Botswana RST Ltd. (BRST), 70%) | Selebi-Phikwe, 350 kilometers northeast of Gaborone | 500 |
| Copper 2/ | | BCL Ltd., (Government, 30%; BRST, 70%) | do. | 25,000 |
| Copper ore | | Tati Nickel Mining Co. (Pty.) Ltd. (AAC, 21%; De Beers, 22%; Francistown Mining and Exploration Ltd., 42%; Government, 15%) | Selkirk Mine, 23 kilometers east of Francistown | 80,000 3/ |
| Diamond | million carats | Debswana Diamond Co. (Pty.) Ltd. (Government, 50%; De Beers Centenary AG, 50%) | Orapa, Letlhakane, and Jwaneng, respectively 375 kilometers north, 350 kilometers north, and 115 kilometers north of Gaborone | 18 e/ |
| Gemstones, semiprecious | kilograms | Agate Botswana (Pty.) Ltd. | Processing plant at Pilane, 45 kilometers north of Gaborone | 60,000 |
| Do. | do. | Masa Precious Stones (Pty.) Ltd. | Bobonong, east of Selebi-Phikwe | 4,000 |
| Gold bullion 4/ | do. | Monarch Goldfields Botswana (Pty.) Ltd. (Gallery Resources NL of Australia, 100%) | Monarch Mine, just north of Francistown | 600 5/ |
| Nickel 2/ | | BCL Ltd., (Government, 30%; BRST, 70%) | Selebi-Phikwe, 350 kilometers northeast of Gaborone | 23,000 |
| Nickel ore, in concentrate | | Tati Nickel Mining Co. (Pty.) Ltd. (AAC, 21%; De Beers, 22%; Francistown Mining and Exploration Ltd., 42%; Government, 15%) | Selkirk Mine, near Francistown<br>Phoenix Mine, near Francistown | 60,000 6/<br>80,000 |
| Salt | | Botswana Ash (Pty.) Ltd. (Government, 50%; Anglo-American 50% ) | Sua Pan, 450 kilometers north of Gaborone | 650,000 |
| Soda ash | | do. | do. | 300,000 |

e/ Estimate.

1/ For brick and tiles.

2/ In nickel-copper-cobalt smelter matte.

3/ Copper content estimated at 2%.

4/ Botswana bullion typically had silver content estimated at 2%.

5/ Mine placed on care and maintenance during May 1995; reopened in Oct. 1996.

6/ Nickel content estimated at 2.4%.

## THE MINERAL INDUSTRY OF

# BURKINA FASO

### By William C. Butterman

Burkina Faso's economy is dominated by services and agriculture, which together account for more than three-fourths of its gross domestic product (GDP). Cotton is the most important cash crop and the most important export commodity. The minerals sector, which is dominated by gold mining, typically has accounted for only 1% to 2% of the GDP. Given the decline of gold production in recent years, the contribution in 1996 was probably close to or below the lower percentage.

Gold was the only mineral exported in quantity in 1996. With the sharp decrease in output from the Poura Mine, artisanal production has become the predominant source of gold in the last few years. It has been estimated that in recent years 40% to 60 % of artisanal gold has been smuggled out of the country; the smuggled gold is not accounted for in official figures for gold production (U.S. Bureau of Mines, 1993). Given the Government's stated intention to eliminate its export monopoly on gold, which has been administered by the Comptoir Burkinabè des Métaux Précieux (Ministère de L'Energie et des Mines, 1996), data on the production and export of gold are expected to become more transparent. Imports were dominated by capital goods and food. Refined petroleum products made up the greater part of the cost of mineral imports, and cement, clinker, and fertilizers accounted for most of the rest.

Burkina Faso has considerable mineral potential for diamonds, gold, limestone, manganese, phosphate, and zinc. Most of the country is underlain by Precambrian rocks of the Birimian shield. These granitoids and gneisses are cut by numerous discontinuous northeast- and north-northeast-trending shear zones and associated belts of greenstone, the steeply dipping reefs of metamorphosed volcanosedimentary rocks that host most of the precious and base metal mineralization in West Africa. The westernmost part of the country is underlain by Precambrian and Paleozoic sedimentary rocks, in which a few small deposits of bauxite and marble are located. A small part of the southeastern corner of the country is underlain by sedimentary rocks that host a number of phosphate deposits, including at least one (Arli) that has been mined in the past.

With the development in the 1990's of a new mining policy, in which was incorporated a new mining code (Ministère de L'Energie et des Mines, 1996), investment by foreign companies became much more attractive, and a minerals exploration rush—largely a gold rush—ensued. By 1995, the Ministère de l'Energie et des Mines was dealing with so many applications for exploration permits that it decided to increase the number of available concessions by limiting individual permits to 500 square kilometers (km$^2$) (U.S. Geological Survey, in press). By yearend 1996, 90 concessions had been established on greenstone terranes. The interest in Burkinabè exploration by foreign companies was fueled by the new mining code; favorable fiscal policies, such as the absence of restrictions on repatriation of profits and invested capital; good basic geological and geophysical information, some gathered in previous years by Government- and United Nations-directed surveys; and the availability of technically trained people. At the same time, modern heap-leach technology made it possible to consider low-grade gold mineralization that had been ignored in the past because it could not be economically exploited. Until very recently, exploration in the country was confined to high-grade quartz veins; now, companies are examining the low-grade stockwork quartz and low-grade wallrock.

The most important gold deposit being exploited in 1996 was the Poura deposit, 200 kilometers (km) west of Ouagadougou, operated by the parastatal Société de Recherches et d'Exploitations Minères du Burkina. Through 1995, Poura had yielded an estimated 19,000 kilograms (kg) of gold from high-grade quartz veins. As 1996 began, a joint venture of two Canadian companies, International Gold Resources Corp. (IGR) and Echo Bay Mines, was exploring Poura and the surrounding 500-km$^2$ concession. IGR held an option to earn a 90% interest in the mine and the concession. A $13.3 million grant awarded to the Burkina Faso Government by the European Development Fund was to be used to aid in the rehabilitation of the mine. In June, IGR and its interest in Poura were acquired by Ashanti Goldfields Co. Ltd., of Ghana. In April 1997, Ashanti transferred its interest in Poura to Sahelian Goldfields, Inc., another Canadian company, which planned to continue exploration and mine rehabilitation and development. In addition to production at Poura, artisanal production came from several locations scattered around the country.

Of the dozens of exploration projects in Burkina Faso, the following, described in the trade press, are representative. High River Gold Mines (Canada) began exploration of the Taparko concession in east-central Burkina Faso and planned to spend nearly $6 million in 4 years on exploration at Taparko to earn a 61.5% interest in the venture; Incanore Resources (Canada) and the Government of Burkina Faso were to hold the balance. Kinbauri Gold (Canada) was drilling on three concessions, of which the most advanced project at the beginning of the year was the 314-km$^2$ Dossi concession, about 200 km southwest of Ouagadougou. The other concessions were the 493-km$^2$ Oula, 160 km northwest of Ouagadougou, on which Kinbauri held an option from Southern Rio Resources (Canada) to earn a majority interest and the 478-km$^2$ Soukoura, 330 km southwest of Ouagadougou, in the southwestern part of the country. The joint venture of Randgold Resources (South Africa), North Ltd. (Australia), and Faso Études Travaux (Burkina Faso) continued work on the Sanmatenga project, consisting of three concessions (Sanmatenga, Foulgo Alga, and Foulgo Sika) covering 3,500 km², 100 km north of Ouagadougou. In addition to its work on the Poura permit, the IGR/Echo Bay Mines joint venture explored the Youga and the Tamberi concessions. Ascot Resources (Canada) conducted a drilling program on its Koupela permit, a wholly-owned property 80 km southeast of Ouagadougou. Golden Knight (Canada) began exploration of vein-type and related low-grade deposits at its Comidok and Seguenega permits. Emerging Africa Gold Inc., an affiliate of Ste. Genevieve Resources (Canada), secured exploration licenses for the 1,000-km² Piela concession, in eastern Burkina Faso, and for three contiguous concessions, Tigan, Dama, and Nimima, totaling 1,400 km² in the western part of the country. Over the course of the year, the Canadian company Société pour l'Exploration Minière en Afrique de l'Ouest acquired 75% interests in each of 14 concessions in greenstone terranes throughout the country. The joint venture of Orezone Resources (Canada) and Geomaque Exploration (Canada) was to begin a drilling program late in the year on the 500-km² Intiédougou permit, 100 km east of Bobo Dioulasso and east of the Houndé greenstone belt. European Mining Finance continued drilling on the Guiro deposit and were reporting an indicated resource of about 2,700 kg of contained gold by April. Channel Resources (Canada) continued drilling and began prospecting and surface sampling on its Bouroum concession in north-central Burkina Faso. The company also conducted exploration of several types on the Barao, Bouroum North, Bombore, Madougou, Somifa, Subeiga, and Tounte concessions. Santa Fe Pacific Gold Corp. (United States) and IMAR-B (Burkina Faso) formed a joint venture and prepared to explore the 500-km² Poni permit. Oxford Resources (Canada) held permits for the Bola-Niobare, Kari, Rambobo, Tcheriba, and Tioro properties.

InterStar Mining Group, Inc. (Canada) secured a gold exploration permit covering 429 km² near the Tambao manganese project in the northeastern corner of the country. InterStar also continued to explore and develop the high-grade Tambao manganese deposit, but the high cost of moving the manganese ore 249 km to the nearest railhead and then on to ocean ports continued to deter full-scale operation.

The Governments of Burkina Faso and Ghana continued talks, begun in 1995, on the construction of a pipeline for petroleum products, between Ouagadougou and Buipe via Bolgatanga.

The International Fertilizer Development Center held a seminar in October in Burkina Faso to develop and implement a national strategy for the large-scale use of the country's phosphate rock. Current production capacity was said to be 3,500 metric tons per year (t/y); it was recommended that it be raised over a number of years to about 60,000 t/y (International Fertilizer Development Center, 1996).

## References Cited

International Fertilizer Development Center, 1996, Seminar on large-scale use of Burkina Faso phosphate rock produces national action plan: IFDC Report, v. 21, no. 2, p.4-6.

Ministère de L'Energie et des Mines, 1996, Statement of Mining Policy: Ministere de L'Energie et des Mines, pamphlet, 14 p.

U.S. Bureau of Mines, 1993, The mineral industry of Burkina Faso: U.S. Bureau of Mines Minerals Yearbook 1993, v.3, p.21.

U.S. Geological Survey, in press, The mineral industry of other countries of West Africa: U.S. Geological Survey Minerals Yearbook 1995, v. 3.

TABLE 1

BURKINA FASO: ESTIMATED PRODUCTION OF MINERAL COMMODITIES 1/

(Thousand metric tons unless otherwise specified)

| Commodity 2/ | | 1992 | 1993 | 1994 | 1995 | 1996 |
|---|---|---|---|---|---|---|
| Gold 3/ | kilograms | 5,400 | 5,000 | 4,000 | 3,000 | 4,000 |
| Manganese, Mn content of ore | | -- | 17 | 30 | 9 | 10 |
| Pumice and related volcanic materials | | 10 | 10 | 11 | 11 | 11 |
| Salt | | 7 r/ | 7 r/ | 7 r/ | 7 r/ | 7 |
| Stone, marble | | 100 | 100 | 110 | 110 | 110 |

r/ Revised.

1/ Includes data available through Dec. 1997.

2/ In addition to the commodities listed, other industrial minerals and construction materials (phosphate, sand and gravel, etc.) are produced, but information is inadequate to make reliable estimates of output.

3/ Includes undocumented artisanal production.

## THE MINERAL INDUSTRY OF

# CAMEROON

### By Philip M. Mobbs

Crude oil production continued to be of major economic importance to Cameroon, accounting for the bulk of the nation's foreign exchange earnings. In the previous decade, the petroleum sector accounted for about 45% of total Government revenues. However, production from existing oilfields has declined since 1994. Without new commercial liquid hydrocarbon discoveries, Cameroon could become a net energy importer by the turn of the century.

The legal system of Cameroon was modeled after French civil law. The mineral policy of Cameroon was based on the Mining Code, law 64-LF-3 of April 6, 1964, and Decree 64-DF-163 of May 26, 1964. Other pertinent legislation included the Mining Taxation Code, law 64-LF-13 of November 18, 1968, and the decrees regulating oil companies, law 82-20 of November 26, 1982 and law 95/13 of 1995.

The primary mining organization in Cameroon was the Government's Ministry of Mines, Energy, and Water Resources. The Government actively promoted investment in the mining sector, and foreign companies were usually involved in joint ventures with Cameroonian partners. Société Nationale des Hydrocarbures (SNH) was the state-owned company involved in hydrocarbon exploitation. SNH consulted with the Ministry of Mines, Energy, and Water Resources in the awarding of exploration permits and production concessions. Under current production-sharing agreements, the Government was entitled to 60% to 70% of total domestic crude petroleum production from the existing operators, depending on the production levels.

Additionally, the Government enterprise Fonds de Soutien aux Hydrocarbures assisted oil exploration and production; and the Société Nationale de Raffinage (Sonara) was the state-owned company that managed the crude oil refining facilities. SNH held a 20% equity share of the Sonara refinery.

Crude petroleum remained the major mineral commodity of Cameroon. *(See table 1.)* The most prolific crude oil-producing regions were the offshore Rio del Rey Basin, northwest of Victoria, and the adjacent Lokélé concession about 35 kilometers offshore. The main petroleum operators in Cameroon were France's Société Nationale Elf Aquitaine subsidiary Elf Serepca (Elf), Pecten International Co. (Pecten), a subsidiary of Shell Oil of the United States, and Perenco of the United Kingdom. Pecten and Elf accounted for about 80% of Cameroon's oil production. Exploration was centered in the Douala Basin.

Exxon Exploration & Production Chad proposed to construct a pipeline from Chad's Doba Basin to the terminal at Kribi, Cameroon. Sonara's 42,000-barrel-per-day refinery at Limbe was running at less than full capacity and Cameroon and Nigeria continued to contest their land and maritime border in the Bakasi Peninsula area.

The aluminum smelter at Edea was managed by Compagnie Camérounaise de l'Aluminium (Alucam). Alucam's equity ownership was by Pechiney of France (58%) and the Government (42%). The smelter had a design production capacity of 85,000 metric tons per year and utilized alumina imported from Guinea. Capacity expansion of the Edea smelter remained in the planning stages, constrained by power availablilty. Cameroon had installed generating capacity of 719 megawatts (MW), which was provided by three hydroelectric stations. An additional 200-MW plant was proposed for the Sanaga River. A portion of the power generated from the new plant could allow an expansion of the Edea smelter. The proposed development of bauxite resources at Minim-Martap and Ngaouanda remained on the drawing board.

According to World Bank estimates, recoverable crude oil reserves in Cameroon's mature oilfields were about 210 million barrels. Reserves of natural gas were considerable, estimated at 100 billion cubic meters. Cameroon hosted a variety of mineral occurrences, reported by the Government to include the following: bauxite, chrome, cobalt, copper, dimension stone, gemstones, gold, iron ore, lead, nickel, phosphate, salt, tin, titanium, and uranium (Ministry of Mines, Water, and Energy Resources, 1995). However, few have been commercially exploited; and the development of a viable and diversified mineral industry was hampered by inadequate infrastructure, insufficient electrical power, and a dearth of financing.

## References Cited

Ministry of Mines, Water, and Energy Resources, 1995, Mineral and Energy Potential of Cameroon: Yaoundé, Cameroon, 2 p.

## Major Source of Information

Ministere des Mines, de l'Eau et de l'Energie
P.O. Box 955
Yaoundé, Cameroon
Telephone: (237) 22-34-00
Fax: (237) 22-61-77

## TABLE 1
## CAMEROON: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

| Commodity 2/ | | 1992 | 1993 | 1994 | 1995 | 1996 e/ |
|---|---|---|---|---|---|---|
| Aluminum metal, primary | | 82,500 | 86,500 | 81,100 e/ | 79,300 r/ | 82,000 |
| Cement, hydraulic e/ | | 620,000 | 620,000 | 620,000 | 620,000 | 600,000 |
| Gold, mine output, Au content e/ | kilograms | 1,000 r/ | 1,000 r/ | 1,000 r/ | 1,000 | 1,000 |
| Petroleum: | | | | | | |
| Crude | thousand 42-gallon barrels | 50,370 | 42,705 | 47,140 | 39,400 r/ | 33,000 |
| Refinery products e/ | do. | 8,400 | 8,400 | 8,000 | 9,000 | 9,200 |
| Pozzolana e/ | | 130,000 | 130,000 | 130,000 | 130,000 | 100,000 |
| Stone: e/ | | | | | | |
| Limestone | | 57,000 | 57,000 | 57,000 | 57,000 | 50,000 |
| Marble | | 200 | 200 | 200 | 200 | 200 |
| Tin, ore and concentrate: e/ | | | | | | |
| Gross weight | kilograms | 4,300 | 4,300 | 3,000 | 2,000 | 1,000 |
| Sn content | do. | 3,050 | 3,000 | 2,300 | 1,500 | 750 |

e/ Estimated. r/ Revised.

1/ Includes data available through June 16, 1997.

2/ In addition to the commodities listed, modest quantities of unlisted varieties of crude construction materials (clays, gravel, sand, and stone) presumably are produced, but output is not reported, and available information is inadequate to make estimates of output levels.

## THE MINERAL INDUSTRY OF

# CENTRAL AFRICAN REPUBLIC

### By Philip M. Mobbs

The Central African Republic's mining industry remained dominated by the production and export of alluvial diamond and gold. The mining sector of the Central African Republic historically contributed about 4% of the nation's gross domestic product and accounted for 40% to 50% of export earnings. However, multiple military mutinies adversely affected the industry in 1996 and resulted in decreased mineral production.

Mining legislation in the country was based on the Mining Code, law No. 61/208, of April 11, 1961. Permission of the Ministry of Mines was required for mining and purchasing of precious stones and minerals. Hydrocarbon legislation was based on the Petroleum Code, Ordinance No. 73/016, of February 10, 1973. The Investment Code of 1990 encouraged foreign investment through guarantees against nationalization, expropriation, and freedom from political or economic interference under certain circumstances. The National Action Plan in Favor of the Environment was proposed during the year to minimize the adverse effects of illegal alluvial mining.

The export market of the country was dominated by diamond. However, actual production and export figures for both diamond and gold were unavailable because of widespread smuggling. *(See table 1.)*

Gold was recovered primarily by artisanal miners. United Reef Ltd. of Canada assigned its Roandji concession, approximately 300 kilometers (km) northeast of Bangui, to a joint venture with Asquith Resources Inc. of Canada in return for exploration financing. The joint venture completed the initial geochemical, geologic, and geophysical surveys of the property. After delineating six prospects on the concession, United Reef began drilling the Agoudou Manga prospect in November 1996.

Diamond production supported an artisanal labor force estimated at about 40,000. Diamond mining cooperatives were active as well as Howe Centrafrique Ltd. and Radisson Centrafrique S.A.

United Reef Ltd. of Canada (52%), Trans Hex Group Ltd. of South Africa (28%), and local nationals (20%) established a joint venture on the Bamingui and Boungou diamond concessions. The Trans Hex Group subsequently transferred its interest in the joint venture to its Canadian subsidiary, Trans Hex International Ltd. The Bamingui concession, 650 km northeast of Bangui, included the Bamingui and Bangoran River systems and the 30-ton-of-gravel-per-hour-capacity diamond and gold recovery plant at Mbala. The Boungou concession was 150 km south of Bamingui. Howe Centrafrique, the local subsidiary of United Reef, was trenching along the Bangoran River, 8 km north of Mbala.

Radisson Centrafrique, a subsidiary of Radisson Mining Resources Inc. of Canada, put two diver-operated dredges into service on the Lobaye River. PR Mining & Explorations Ltd. of South Africa retained an option to acquire 25% interest in the diamond concession.

The diamond exchange in Bangui was reopened in November 1996 after closing in May because of the military unrest.

Other mineral occurrences reported in the Central African Republic by the Direction Générale des Ressources Minérales in 1995 included clay, copper, iron ore, lignite, limestone, manganese, rutile, tin, and uranium (Ministère des Ressources Energétiques et Minérales, 1995). However, the lack of adequate transportation and industrial infrastructure, including the absence of a railway system, hindered the nation's mineral industry development.

#### References Cited

Central African Republic, Ministère des Ressources Energétiques et Minérales, Direction Générale des Ressources Minérales, 1995, The Mineral Sector of the Central African Republic — An Introduction: Bangui, Central African Republic, 38 p.

#### Major Sources of Information

Ministère des Ressources Energétiques et Minérales
Direction Générale des Ressources Minérales
Bangui, Central African Republic
Telephone: (236) 61-20-54
Fax: (236) 61-06-66

## TABLE 1
## CENTRAL AFRICAN REPUBLIC: PRODUCTION OF MINERAL COMMODITIES 1/

(Carats unless otherwise specified)

| Commodity 2/ | 1992 | 1993 | 1994 | 1995 | 1996 e/ |
|---|---|---|---|---|---|
| Diamond: | | | | | |
| Gem e/ | 307,442 3/ | 369,923 | 400,940 r/ | 400,000 | 350,000 |
| Industrial e/ | 106,522 3/ | 125,000 | 131,000 | 130,000 | 120,000 |
| Total | 413,964 | 494,923 | 531,940 | 530,000 e/ | 470,000 |
| Gold kilograms | 155 | 153 r/ | 138 r/ | 120 r/ e/ | 90 |

e/ Estimated. r/ Revised.

1/ Includes data available through Mar. 18, 1997.

2/ In addition to the commodities listed, modest quantities of unlisted varieties of crude construction materials (clays, gravel, sand, and stone) presumably are produced, but output is not reported, and available information is inadequate to make estimates of output levels.

3/ Reported figure.

### THE MINERAL INDUSTRY OF

# CHAD

### By Philip M. Mobbs

The mineral industry of Chad was dominated by small scale clay, gravel, natron (soda ash), salt, and sand production, complemented by artisanal recovery of diamond and gold. Mining did not play a significant role in the Republic of Chad's economy. The Government was actively encouraging foreign investment, but the nation's landlocked geography, political risk, lack of suitable infrastructure and process water apparently were impediments to international companies. Mining legislation in Chad was based on the Code Minier of June 20, 1995.

Chad's Direction de Recherches Géologiques et Minières (DRGM) funded by the United Nations Development Program (UNDP) had identified tin, tungsten, and uranium mineralization in the Tibesti massif in the northwestern part of the country during the 1980's. In the southwest, the UNDP/DRGM had studied the bauxite deposit at Koro de Laï, an estimated 7 million metric tons grading 57% $Al_2O_3$, and the gold mineralization in the Mayo Kebbi greenstone belts. Diatomite, dolomite, granite, kaolin, limestone, and marble deposits were also reported (Mining Journal (London), 1995).

Chad had no significant hydrocarbon production. However, Esso Exploration and Production Chad Inc. (40%) was the operator of a joint venture, with Shell Tchadienne de Recherches et d'Exploration (40%) and Elf Hydrocarbures Tchad (20%), that proposed to drill approximately 300 wells to develop the Doba Basin, 350 kilometers south of N'Djamena.

Much of the nation's commerce relied heavily on roadways, although some mineral trade moved via the Logone River. Esso was planning the construction of a 76-centimeter-diameter pipeline from Chad to an export terminal south of Kribi, Cameroon.

Traditional fuels such as wood were still heavily utilized in Chad. All electrical power was produced by diesel generators utilizing imported fuel. Total installed electric generating capacity, managed by Société Tchadienne d'Energie Electrique, amounted to 38 megawatts. Only the major cities of N'Djamena, Moundou, and Abéché possessed electric power, and they were not interconnected. The communications network infrastructure was embryonic.

#### References Cited

Mining Journal (London), 1995, Chad—Discovering new mineral wealth: Mining Journal Country Supplement, v. 325, no. 8345, September 22, 1995, 12 pp.

#### Major Sources of Information

Ministry of Mines, Energy, and Petroleum
  Directorate of Geological and Mining Research
  B.P. 816
  N'Djamena, Chad
  Telephone: (235) 51-54-82
  Fax: (235) 51-25-65
Ministry of Mines, Energy, and Petroleum
  Directorate of Petroleum, New and Renewable Energy
  B.P. 94
  N'Djamena, Chad
  Telephone: (235) 51-51-76
  Fax: (235) 51-33-25

## THE MINERAL INDUSTRY OF

# CONGO

### By Alfredo C. Gurmendi

The Republic of the Congo is increasing its importance as crude oil supplier to the world energy markets with the development of new offshore oilfields. Congo's economy is based largely on crude oil, which accounted for approximately 90% of the country's exports of $1.2 billion and about 15% of an estimated gross domestic product of $7.1 billion[1] for 1996. Congo's total value of imports was about $700 million.

The Government actively encourages foreign investment. The investment code of 1992 should facilitate increased business opportunities and profit reinvestment through tax breaks and easing the bureaucratic process. Congo's hydrocarbon law of 1994, Production Sharing Agreements (PSA's), replaced the previous joint-venture agreements that had been in existence since 1968. Since late 1995, foreign oil companies have been converting their existing exploration and production joint-venture contracts to PSA's. PSA's reduce taxes on produced crude oil from 17.5% to 12% and the State receives, as a profit-sharing 31% of production.

Currently, Congo's mining legislation is based on Law 29-62 of June 1962. The law was amended several times, most recently with Decree No. 86/814 of June 11, 1986. In general, mining is carried out by the State or through state-owned joint ventures.

Recently, the Government introduced a new Mining Code, which is being reviewed by the Council of Ministers prior to being passed by the Congolese Parliament. The proposed code stipulates, for instance, that prospecting and exploration will require licenses; the former licenses are to be valid for 1 year and renewable once, and the latter licenses are to be valid for 3 years and renewable twice for periods of 2 years. Renewal will require a 50% area reduction. An investment agreement will be required and signed with the Government at the start of the license process. Mining operations will require permits, which are to be valid for a maximum of 25 years and renewable for 15-year periods. Environmental impact studies will be required. Also, according to the proposed code, the Government will not have a right to acquire any interest in new mining projects (SAMAX Gold Inc., 1997b).

Equipment for mining operations will be exempted from import duties and internal taxes. The tax rate and capital expenditure allowances are to be provided for in the investment agreement. Royalties will be 5.6% for precious metals such as gold and diamond and 3.5% for other metals. The Government will be paid surface taxes on prospecting and exploration licenses and fees for mining permits.

The Government's economic reform process is targeted to reduce the civil service, to increase private-sector employment, to reduce the budget deficit, and to privatize state-owned companies. In 1996, Congo began the bidding process for the privatization of the Pointe Noire refinery plant. The sale is expected to be completed by early 1997. Congo's state-owned Pointe Noire refinery has a capacity of 21,000 barrels per day (bbl/d). The Government has also announced that the state-owned upstream crude oil production and petroleum products distribution company, Hydro-Congo, is for sale. Its assets include a 60% share in the Coraf Refining Company (Coraf). Coraf is also owned by France's Societe Nationale Elf Aquitaine (Elf), operating through its subsidiary Elf-Congo, 40% (Kronsten, 1996).

The other state-owned companies, Societe Congolaise de Recherche et d'Exploitation Miniere, are involved with the exploitation of all nonfuel ores and minerals, and Societe de Cimenterie du Congo is charged with cement production and sales. Foreign companies and expertise play a primary role in the continuing development of Congo's hydrocarbons sector. The two main foreign oil companies operating in Congo are Elf and Italy's Azienda Generali Italiana Petroli S.p.A. (Agip), which operates through its subsidiary Agip Recherches Congo. After the Congolese Parliament ratified Hydro-Congo's sale of its PSA's shares in Elf-Congo (25%) and Agip Recherches Congo (20%) in 1995, Elf bought the Government's PSA in March 1995 and Agip followed suit and obtained full control of the State's PSA in January 1996.

Congo currently has proven oil reserves of 1.5 billion barrels and about 120.4 billion cubic meters of natural gas reserves (U.S. Department of Energy, Energy Information Administration, unpub. data accessed March 1996 on the World Wide Web at URL http://www.eia.doe.gov/emeu/cabs/chron.txt).

Congo is not a member of the Organization of Petroleum Exporting Countries (OPEC) and not subject to OPEC-imposed production quotas. Congo is producing about 175,000 bbl/d, which is expected to increase to 260,000 bbl/d by 1998, after Elf's N'Kossa and Agip's Kitina oilfields come on-line. More than 90 % of crude oil is produced from offshore sources. Elf is the primary petroleum producer, with about 70 % of Congo's total crude oil output. Elf's most prolific oilfield in Congo is the offshore Tchibouela Field. Elf sold a 7.5% share of its stake in the offshore N'Kossa oilfield to Engen Exploration Ltd. of South Africa in 1994. Hydro-Congo will maintain its 15% interest in the project. According to Elf, the offshore N'Kossa oilfield contains 400 million barrels of crude oil reserves and a total production of 100,000 bbl/d is anticipated by 1998 (U.S. Department of Energy, Energy unpub. data accessed July 2, 1996 on the World Wide Web at URL http://www.eia.doe. gov/emeu/cabs/chron.txt). Accounting for much of the remaining 30% of Congo's oil production is Agip. Agip's most prolific crude oil producer is its offshore Zatchi oilfield.

---

[1] Where necessary, values have been converted from Communaute Financiere Africaine francs (CFA) to U.S. dollars at the rate of CFA497=US$1.00.

New hydrocarbon discoveries are in the development stages, which should eventually contribute to overall export earnings. Most exploration activities in Congo are focused on deepwater offshore areas. In 1995, the most successful exploration well was Chevron's and Elf's Moho Marine I discovery located 76 kilometers (km) offshore in the Haute Mer concession. A drilling effort in 792 meters of water resulted in a flow rate of 5,700 bbl/d. The Moho well has led to an estimate of 300 million barrels of crude oil reserves. Subsequent drilling could increase these reserves, possibly up to 1 billion barrels (U. S. Department of Energy, Energy Information Administration, unpub. data accessed March 1996 on the World Wide Web at URL http://www.eia.doe.gov/emeu/cabs/chron.txt).

The country exports about 168,000 bbl/d of crude oil mainly to the United States and France. France supplies about 50% of Congo's imports, which include heavy machinery, vehicles, clothing, consumer goods, medicines, business equipment, and foodstuff. The United States accounts for only 2 % to 4% of Congo's total imports because of high transport costs.

The Government's Ministry of Mines stated that exploitable minerals in Congo include base metals (copper, lead, and zinc), diamond, gold, and platinum. Coastal deposits of phosphate and potash have yet to be fully exploited. Additionally, deposits of bentonite, granite, gypsum, kaolin, marble, and talc also were found in Congo. Base metals mineralization is concentrated in the Niari district, which contains (as official records indicate) up to 10 million metric tons (Mt) of ore reserves. About 7 Mt of the base metals ore grade an average of 9% Pb, 2% Zn, and 1% Cu in the Yanga-Koubanza complex of western Niari (Kronsten, 1996). One of the largest impediments to mineral development in Congo is the lack of an adequate transportation infrastructure.

AfriOre Limited (AfriOre) of Canada announced that it has agreed to acquire 50% interest in a prospecting permit in Congo from Purity Metals Limited (PML). The project is between the West Coast of Africa and Brazzaville and consists of a 696-square-kilometers (km$^2$) concession, which contains the dormant M'Fouati and Hapilo lead-zinc mines. In addition, located in the concession area is the Yanga Koubanza mineral occurrence. Drilling has identified three adjacent mineralized ore bodies containing an estimated resource of 3-4 Mt of ore grading 12% lead plus lenses of high-grade zinc (AfriOre Limited, 1996; The Northern Miner, 1996). AfriOre has undertaken to prepare a feasibility study. If the study that is currently underway is warranted, AfriOre will finance the entire study and increase its interest to 60%.

SAMAX Gold Inc. of Australia holds an 85% interest in a 6,500-km$^2$ reconnaissance license for gold exploration on the entire Mayombe gold belt in the southwestern Congo area, which currently has two large gold exploration licenses, Kakamoeka with 2,500 km$^2$ and Dimonika with 1,050 km$^2$. The belt covers all the main areas of past and present alluvial and elluvial gold production, or 80% of gold produced in the country. In Kakamoeka, the most advanced prospect, extensive sulfide vein and hydrotermal alteration has been discovered and Dimonika is currently under evaluation (SAMAX Gold Inc., 1997a).

Panorama Resources NL (Panorama) of Australia is currently involved in prospecting gold in Congo. Moussendjo is a gold prospect in northwestern Congo about 320 km northwest of Brazzaville and 200 km northeast of Pointe Noire. Panorama's subsidiary Auvista Minerals NL (Auvista) entered into an option agreement in the first quarter of 1996 with the Congolese registered mining company La Generale Congolaise Minière de Fabrication et de Fournitures (LGCMFF) on a concession covering some 8,000 km$^2$ centered in the northwestern Congo area. The most significant greenstone belts within the concession are Mayoko and Zanaga. LGCMFF will prospect for gold and other minerals, mainly bauxite, diamond, and tantalite, during the next 3 years; and expenses will be reimbursed by Auvista by the end of the decade. LGCMFF will revert to a 2% royalty on gross revenue, and Auvista may withdraw at any time (Panorama Resources NL, p. 10).

Congo is a net electricity importer. The country currently has an electrical generation capacity of about 160 megawatts (MW). The country's main source of power are the 74-MW Bouenza and the 15-MW Djou hydroelectric plants. However, the $925-million, 1-gigawatt Sounda Gorge hydroelectric project will increase Congo's power generating capacity. Presently, a 3-phased construction plan is underway at the Limpopo River site 137 km north of Pointe Noire.

Environmentally, Congo has experienced some offshore oil spills, natural gas flaring, and a decline in forest ecosystems in recent years. Unregulated logging has destroyed some forest animal habitats. Congo is second only to Zaire in its range of tropical forests, accounting for 62% of the country's territory.

## References Cited

AfriOre Limited, 1996, [untitled]: Ontario, Canada, AfriOre Limited press release: September 20, 2p.

Kronsten, Gregory, 1996, Congo: Mining Annual Review [London], folio 794 Congo, 1 p.

Panorama Resources NL, Annual report 1996: Perth 6000 Western Australia, 47p.

SAMAX Gold Inc., 1997a, Country overview—Republic of Congo: SAMAX Gold Inc., February 3, [unpaginated flyer].

———1997b, Moyombe gold prospects—Republic of Congo: SAMAX Gold Inc., February 3, [unpaginated flyer].

The Northern Miner 1996, AfriOre expands in Republic of Congo: The Northern Miner, v. 82, no.31, September 30, p. 3.

## Major Source of Information

Ministry of Mines
Director of Mineral Resources
Brazzaville, Congo
Telephone: (242) 83 58 73; Fax: (242) 83 62 43

## Major Publications

Africa Energy & Mining, annual.
U. S. Department of Energy, Energy Information Administration Report, annual.

## TABLE 1
## CONGO: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

| Commodity | | 1992 | 1993 | 1994 | 1995 e/ | 1996 e/ |
|---|---|---|---|---|---|---|
| Cement, hydraulic | | 114,854 | 114,000 e/ | 121,000 r/ | 121,000 | 121,000 |
| Gas, natural: e/ | | | | | | |
| Gross | million cubic meters | 360 | 360 | 368 r/ 2 | 368 | 370 |
| Marketed | do. | 350 | 350 | 350 | 350 | 350 |
| Gold, mine output, Au content | kilograms | 5 | 5 e/ | 12 | 12 | 10 |
| Lime | | 240 | 240 e/ | 390 | 390 | 390 |
| Petroleum, crude | thousand 42-gallon barrels | 58,035 | 61,000 r/ | 65,700 | 63,875 2/ | 63,875 2/ |

e/ Estimated. r/ Revised.

1/ Includes data available through May 1997.

2/ Reported figure.

### THE MINERAL INDUSTRY OF

# CÔTE D'IVOIRE

### By Philip M. Mobbs

Primarily an agrarian economy, Côte d'Ivoire's mineral industry was a modest factor in determining the nation's gross domestic product. However, the country's Birimian greenstones have attracted considerable attention from international gold exploration companies. More significantly, renewed interest in the hydrocarbon potential of the West African offshore basin by international petroleum companies will significantly increase the mineral fuels sector importance to the economy. Côte d'Ivoire progressed rapidly from being wholly dependent on imported fuels at the start of 1995 to energy self-sufficiency at the end of 1996 (Adams, 1996). Other mineral production was relatively meager. *(See table 1.)*

The Government actively encouraged the responsible development of the country's mineral resources and the variety of mineral resources in Côte d'Ivoire was noteworthy. The state mining company, Société pour le Développement Minier (SODEMI) had documented numerous mineral deposits, including bauxite, brick clay, ilmenite, iron ore, manganese, lateritic nickel, rutile, glass sand, dimension stone, and tantalite (République de Côte d'Ivoire, Ministère des Mines et de l'Energie, 1994). Law No. 95-553 of July 18, 1995, the new Mining Code, replaced Law No. 64-249 of July 3, 1964. The 1996 Hydrocarbon Code replaced the Petroleum Code (Law No. 70-849 of August 3, 1970).

The Ministère des Mines et de l'Energie held the primary role of mineral development in Côte d'Ivoire through its ownership of SODEMI. SODEMI promoted and participated in the exploration and development of nonhydrocarbon mineral resources. La Société Nationale d'Opérations Pétrolières de la Côte d'Ivoire (Petroci) was the state-owned company charged with managing the hydrocarbons sector. Petroci maintained a minimum 10% interest in all petroleum operations.

The Société des Mines d'Ity, a joint venture of LaSource Group of France (40%) and SODEMI (60%), operated the open pit Ity gold mine, 90 kilometers (km) southwest of Man in the west of the country. The Government initiated privatization of its interests in the company during 1996. However, unexpected lower ore grades, crusher-related problems, and problems with artisanal miners reduced output at Ity during the year.

The Société des Mines d'Afema (Somiaf) operated the Afema Mine, a three-pit heap-leach operation, 120 km east of Abidjan. Eden Roc Mineral Corp. of Canada held 68% of Somiaf, and SODEMI held the remaining 32%. Gold production at Afema decreased in 1996 to 622 kilograms (kg) from 766 kg in 1995 (The Northern Miner, 1997). The decreased output was attributed to heavy rainfall adversely affecting pit and heap-leach operations and continued agglomeration problems. Production was expected to rebound in 1997 because Somiaf was doubling the capacity of the absorption-desorption recovery plant and it reportedly had solved the agglomeration problems.

A number of international companies were engaged in exploration for gold on exploration permits in Côte d'Ivoire including: Anmercosa, the local subsidiary of Anglo American Corp. of South Africa; Cie. Minière d'Afrique, the local subsidiary of LaSource Group of France; Cluff Mining Ltd. of the United Kingdom; Eden Roc; Equigold NL of Australia; GATRO-CI, the local subsidiary of Gencor Ltd. of South Africa; Goldivoire; Leo Shield Resources Ltd. of Australia; Oxford Resources Inc. of Canada; Pan African Resources Corp.-Côte d'Ivoire, a subsidiary of Golden Star Resources Ltd. of Canada; Randgold Resources of the United Kingdom, a Jersey subsidiary of Randgold & Exploration of South Africa; Stanley Mining Services Ltd. of Australia; Trillion Resources Ltd. of Canada; Western Mining Corp. of Australia; and Winslow Gold Corp. of Canada. Artisanal gold activity exists in Côte d'Ivoire, but production was clandestine and unreported.

Falconbridge International (Investments) Ltd. of Canada continued its multiyear drilling program on the Touba-Biankouma nickel prospect. Touba-Biankouma, approximately 500 km northwest of Abidjan, consisted of several lateritic nickel deposits, including the Sipilou deposits. Trillion Resources Ltd. of Canada, a partner in the project (Falconbridge, 60%; Government, 25%; and Trillion, 15%) reported total indicated and inferred resources of approximately 225 million metric tons grading 1.5% nickel and 0.1% cobalt (Trillion Resources Ltd. News Release, 1996/97 Field Program Underway—Touba-Biankouma Nickel Project - Côte d'Ivoire, October 11, 1996). Diamond mining at Tortiya and Séguéla was primarily artisanal.

Côte d'Ivoire's petroleum production had ceased in 1992 when the Bélier Field was abandoned. Production resumed during 1995 when United Meridian Corp. (UMC) of the United States, began flowing oil from the Lion Field, approximately 13 km offshore. UMC operated the Lion Field and Panthere Gasfield on block CI-11. Partners include Petroci; the International Finance Corp., an affiliate of the World Bank; Global Natural Resources Inc., which during October 1996 merged with and subsequently became a subsidiary of Seagull Energy Corp. of the United States; and Pluspetrol S.A. of Argentina. Partnership interest varied from well to well in the fields. UMC drilled four wells on block CI-11 and the Leopard #1 Well on block CI-12 during 1996. UMC also drilled the Kudu #1 on block CI-01. During the year, UMC and Shell Exploration Africa BV of the Netherlands obtained a production-sharing concession for the deep-water block CI-105.

Santa Fe Energy Resources of the United States obtained a contract to explore block CI-24 during October 1996. Addax Petroleum Ltd., a Swiss oil trader, continued looking for an operating partner to redevelop the Espoir Field on block CI-26. Apache International (a subsidiary of Apache Corp. of the United States), Petroci, and Electricité de France-SAUR of France drilled a confirmation well in the undeveloped Foxtrot prospect on block CI-27. ELF of France secured short-term options on blocks CI-40, CI-101, CI-102, and CI-103 during 1996. The Government and Seagull Energy entered into a production-sharing contract on block CI-104.

Cie. de Production d'Electricité de Côte d'Ivoire (CIPREL) purchased natural gas from the UMC consortium for its Vridi powerplant. CIPREL could become an electrical energy exporter as both its generating capacity and natural gas supply from Panthere Field were projected to be increased. CIPREL's fuel supply could be further augmented by the proposed gas production from the Foxtrot prospect. Natural gas has supplanted imported fuel for the powerplant of the Société Ivoirienne de Raffinage petroleum refinery and has been proposed as a power source and feedstock for the fertilizer plant.

## References Cited

Adams, P., 1996, Deep-water hopes buoy UMC shares: Financial Times (London), October 4, 1996, p. 26.

The Northern Miner, 1997, Eden Roc proves up Ivorian gold deposit: May 5, 1997, p. 11.

République de Côte d'Ivoire, Ministère des Mines et de l'Energie, 1994, An outline of geology, mining and mining potential in Côte d'Ivoire: Abidjan, Côte d'Ivoire, 10 p.

## Other Sources of Information

Ministère des Mines et de l'Energie
B.P. V 50
15ème étage, Tour SCIAM
Abidjan, Côte d'Ivoire
Telephone: (225) 21-50-03
Fax: (225) 21-53-20
Société pour le Développement Minier (SODEMI)
01 BP 2816
Abidjan 01, Côte d'Ivoire
Telephone: (225) 44-29-94
Fax: (225) 44-08-21
La Société Nationale d'Opérations Pétrolières de la Côte d'Ivoire (Petroci)
BP V 194
Abidjan, Côte d'Ivoire
Telephone: (225) 21-40-58
Fax: (225) 21-68-24

TABLE 1
COTE D'IVOIRE: ESTIMATED PRODUCTION OF MINERAL COMMODITIES 1/

| Commodity 2/ | | 1992 | 1993 | 1994 | 1995 | 1996 |
|---|---|---|---|---|---|---|
| Cement | thousand metric tons | 510 | 500 | 500 | 500 | 500 |
| Diamond | carats | 15,000 | 15,000 | 84,400 | 75,300 | 75,000 |
| Gold | kilograms | 1,500 | 1,500 | 1,860 | 1,983 3/ | 1,000 |
| Natural gas | million cubic meters | -- | -- | -- | 36 r/ | 450 |
| Petroleum: | | | | | | |
| Crude | thousand 42-gallon barrels | 300 | -- | -- | 2,000 r/ | 6,000 |
| Refinery products | do. | 17,200 | 18,300 | 19,300 r/ | 19,300 r/ | 20,000 |
| Tantalite | kilograms | -- | -- | -- | 500 | 500 |

r/ Revised.
1/ Includes data available through May 1997.
2/ In addition to the commodities listed, Côte d'Ivoire produced clays, crushed granite, sand and gravel, and stone for the local construction industry. Information is inadequate to make reliable estimates of output levels.
3/ Reported figure.

### THE MINERAL INDUSTRY OF

# EGYPT

### By Bernadette Michalski

The Egyptian economy has been, for the most part, traditionally sustained by mineral and mineral-related industries, particularly by revenues from petroleum and natural gas, and the Suez Canal, and Suez-Mediterranean (Sumed) oil pipeline. In recent years, the hydrocarbons sector accounted for more than 15% of the gross domestic product (GDP); other extractive mineral industries accounted for about 1% of the GDP. Suez Canal revenues were $1.88 billion, a drop from $1.94 billion in 1995[1] (Arab Oil and Gas Directory 1997, p. 109). According to the Central Bank of Egypt, the GDP was $65.48 billion in the fiscal year ending June 30, 1997. In addition to hydrocarbons, Egypt produced a wide variety of metals and industrial minerals. Production levels of these nonfuel minerals, however, remained relatively low when compared with global levels.

Mining legislation dates back to the Mining and Petroleum Code Law 66 of 1953 and the Mining Code Laws 86, and 151 of 1956. These laws provide the legal basis for mineral exploration and exploitation. Law Nos. 43 of 1979 and 50 of 1981 provide the governorates and local councils the power of administration for quarries in their particular districts. Ministerial Decree 8 of 1990 was designed to assist the private sector in obtaining the required permits for mining. The Egyptian General Petroleum Corp. (EGPC) was created under law No. 20 of 1976. Recent petroleum policy requires exploration permits to be awarded as production-sharing agreements and the conversion of all joint ventures into production-sharing agreements.

Law No. 4 of 1994, the unified environmental legislation, empowered the Egyptian Environmental Affairs Agency with the right to enforce environmental regulations and standards at all levels of Egyptian industry. The law also provides for the caveat that any new mining or quarrying projects initially will require an environmental impact assessment. Extant mining operations have a 3-year grace period to conform to the new law, and the Government reserves the right to extend this period for 2 years if progress is made toward compliance with the law.

Egypt is not a member of the Organization of Petroleum Exporting Countries. A Government commission sets the price per barrel of crude oil to be exported. A long-standing pricing formula was discarded and a new pricing system was in effect as of January 1, 1996. The Government's monthly pricing formula for each of its crudes is now expressed as a differential relative to the North Sea Brent crude oil. Oil revenues were $1.323 billion (fiscal year 1995), $1.379 billion (fiscal year 1996), and $1.397 billion (fiscal year 1997).

Efforts at privatization continued with plans to offer possibly as much as a 45% equity in the Aluminium Co. of Egypt (Egyptalum) and a 20% stake valued at $124 million in the Egyptian Iron and Steel Company (Hadisolb).

In 1996, Egypt produced a variety of minerals from more than 600 mines, quarries, and salt deposits. Among nonfuel minerals produced in Egypt, phosphate rock and iron ore remained the most important in terms of value. *(See table 1.)*

Crude petroleum and refined products (mostly fuel oil and naptha) were Egypt's leading exports. Asia remained the biggest market for Egyptian crude oil. Israel has been a major importer of Egyptian crude oil ranging from deliveries of 15 million barrels per year (Mbbl/yr) to as much as 25 Mbbl/yr. The United States imported more than 14 Mbbl/yr of crude oil and petroleum products from Egypt.

Egyptian natural gas exports via a 250-kilometer (km) pipeline to Israel, considered to be a primary outlet owing to its proximity and energy requirements, was closer to realization in 1995 than it has been in the succeeding months. An agreement in principal was concluded with Israel in April 1995 followed by a commitment from Amoco Egypt Oil Company (AEOC) and EGPC to supply Israel with 2 billion to 2.5 billion cubic meters per year of natural gas, during a 20-year period starting in 1999, via a connecting pipeline between the East Mediterranean fields and Israeli and Palestinian consuming centers. The Egypt Trans-Gas Co. was established in November 1995 to manage the export operation. Further negotiations conducted in 1996, however, came to a deadlock reportedly over the price and volume of natural gas. As a possible alternative, a memorandum of understanding was signed between Botas Co. of Turkey, EGPC, and Amoco providing for Egypt to export as much as 10 billion cubic meters per year of liquefied natural gas (LNG) to Turkey beginning in 2000.

Commerce transiting the 193.5-km-long Suez Canal is critical to the Egyptian economy. The Suez Canal generated revenues of $1.88 billion, despite operating below capacity in 1996.

The 320-km-long Sumed pipeline complements the Suez Canal by linking Ain al-Sokhna on the Gulf of Suez to Sidi Krir on the Mediterranean coast. The pipeline's capacity was increased to 2.4 million barrels per day (Mbbl/d) in late 1995, following a long series of improvements since the Sumed opened in 1977 with a 1.5-Mbbl/d capacity. The pipeline is operated by the Arab Petroleum Pipeline Co. whose net income was $74 million compared with $66 million in 1995.

Total Egyptian exports were reported to be nearly $5 billion. in 1996. Of this amount, exports of crude petroleum and products accounted for $2.69 billion. Rolled aluminum product exports totaled 6,000 metric tons (t) with exports principally to the United States and Europe.

---

[1] **Where necessary, values have been converted from Egyptian pounds (£E) to U.S. dollars at a rate of £E3.40=US$1.00.**

Petroleum products also were Egypt's principal mineral import, totaling $1.36 billion. Imports from the United States included 300,000 barrels of petroleum products. Other mineral imports included asbestos, barite, chromite, copper, graphite, iron and steel products, lead, nickel, pumice, silver, sulfur, tin, titanium, tungsten, and zinc. The total value of imports was $14.9 billion.

Most mining and mineral processing in Egypt is carried out by Government-owned mining companies.*(See table 2.)* Privatization has not progressed as rapidly as was originally planned; nearly $0.5 billion were, however, realized from the sale of state-owned assets in 1996.

Egyptalum was on target with its extensive refurbishment and modernization of the Nag Hammadi primary smelter, its rolling mills, and a new aluminum extrusion facility. The modernization project was expected to increase production capacity from 179,000 metric tons per year (t/yr) to 300,000 t/yr by 2000. A possible seventh potline was under consideration. If implemented, then capacity would be increased to 350,000 t/yr by 2005. The alumina supply has been secured by long-term contracts with Billiton, a subsidiary of South Africa's Gencor Ltd., and with the Swiss-based Glencore group; the contracts began in 1996 and will run for 5 and 10 years, respectively.

Although equity in Egyptalum was scheduled for further public offering in 1996, the partial privatization was delayed as the process of valuation of the company had only been completed at yearend.

The Egyptian Geological Survey & Mining Authority identified an oolitic hematite iron ore deposit with proven ore reserves of 100 million metric tons (Mt) of 86% iron oxide in the Eastern Desert about 85 km south of Aswan. Egyptian iron ore was mined in the El Gedida area of El Bahariya Oasis in the Western Desert. Primarily high-grade iron ore, at 55% iron, was mined. All iron ore produced from the El Bahariya Oasis deposit was destined for the Helwan Iron and Steel Works near Cairo.

Alexandria National Iron and Steel Co. has embarked on a $350 million expansion and modernization program that will increase output capacity to 1.5 million metric tons per year (Mt/yr). The expansion program included a $115 million second module of the Midrex direct reduction plant, a $46 million expansion of the steelmaking plant, and a $40 million expansion at the rod-mill plant. Completion is scheduled for 1997. Hadisolb is expected to be the first of Egypt's steel mills to tranfer to partial private ownership. A minority stake in the company is expected to be offered on the Cairo stock exchange in 1998. The public offering receipts are to be applied to the revamping of the 30-cubic-meter-capacity No. 3 blast furnace at the Helwan plant.

The nation's eight cement companies have a combined installed cement production capacity of about 20 Mt/yr. Egypt continued to be virtually self-sufficient in the mineral commodities needed to manufacture cement. The industry has been under increasing pressure, however, to address environmental problems associated with the industry.

Egypt has four nitrogenous fertilizer complexes, the largest of which is in Abu Qir. The others are in Kima, Suez, and Talkha. The nation's three other fertilizer complexes produce phosphate-base fertilizers. Egypt currently imports about 70,000 t/yr of potassium fertilizers with demand projected to rise to 200,000 t/yr by the turn of the century. BHP Minerals International Exploration Inc. continued exploration for potash deposits in a 14,800-square-kilometer (km$^2$) area near Ras Gharib on the Gulf of Suez, and Botas continued exploration over a 14,000-km$^2$ area in the region of the Gulf of Suez and the Red Sea.

The Government opened the Abu Tartor phosphate mine, about 50 km west of the Kharga Oasis in the Western Desert. When at full production, scheduled for 1997, the annual crude phosphate rock output should reach 4.5 Mt at 31% $P_2O_5$, yielding 2.2 Mt of concentrate. The 680-km railway to transport the phosphate from Abu Tartor to Safaga on the Red Sea coast was completed in 1996.

Ilmenite is produced from the Abu Ghalaga Mine in the Red Sea region by El Nasr Phosphate Co. Most of the ilmenite is exported with Europe as the principal destination.

The nation's first coal mine opened in December 1995 in the northern Sinai. The Maghara Mine was expected to ultimately produce 600,000 t/yr for the domestic steel and power industries. The main coal-bearing seam at Haghara was 2 meters (m) thick. The first coal face is 150 m across.

Natural gas accounts for 35% of total energy consumption in Egypt. The Government planned to further utilize natural gas resources through improvements in production, transportation, and infrastructure. EGPC predicted a 12% increase in natural gas production during the next 5 years.

More than one-half of the nation's total natural gas production is derived from two fields—the Abu Madi and the Badreddin-3 Fields. Agip's International Egyptian Oil Co. (IEOC) was the country's leading natural producer at 14.87 million cubic meters per day (Mm$^3$/d) followed by AEOC producing 2.55 Mm$^3$/d. Twelve natural gas plants, with a total capacity of nearly 48 Mm$^3$/d, operate in three different regions of the country—the Mediterranean region (with more than 50% of the total output), the northern edge of the Western Desert (with more than 30% of the output), and the Nile Delta. Some associated natural gas fields also were in production in the Gulf of Suez and the Sinai peninsula. Amoco and EGPC are considering using a string of recent gas finds on the Nile Delta by developing a LNG export project. A memorandum of understanding was signed in November 1996 to this affect. Under study is a single train plant with capacity to produce 4 billion cubic meters per year of LNG. A site west of Port Said has been selected to build the liquefaction plant and export facilities. The gas is to be eventually delivered to Botas to supply planned gas-fired power stations in the Izmir region. Natural gas sales negotiations are under way among Amoco, EGPC, and Botas.

Crude oil output has held steady at about 900,000 barrels per day (bbl/d) for the past decade (Energy Information Administration, 1997). About four-fifths of the country's total output is derived from within the 20,000-km$^2$ Gulf of Suez basin. AEOC, through the Gulf of Suez Petroleum Co., its joint venture with EGPC remained the largest oil producer in the country, producing about 360,000 bbl/d. The second largest producer is IEOC, producing about 290,000 bbl/d. Declining yields in more-mature fields have been offset by improved recovery rates in other fields after artificial lift systems were installed.

Egypt's seven refineries process just over 500,000 bbl/d. The existing refineries produce a disproportionately high volume of fuel oil, which accounts for almost 50% of total refinery output. New refining projects are directed toward increasing production of lighter products and decreasing the need for imports. Among these is the Middle East Oil Refinery, a joint venture with Israel. The export refinery, under construction in Alexandria, is scheduled for completion in 1999. It is to process 100,000 bbl/d of crude oil and will include a 25,000-bbl/d hydrocracker geared to produce light products.

Egypt's first petrochemical complex, to be constructed in Alexandria, is being developed by a newly created joint stock firm Sidi Krier Petrochemicals in partnership with banks and insurance companies.

Egypt's crude petroleum reserves were reported to be 3.1 billion barrels. Egypt's natural gas reserves are 680 billion cubic meters and include recent new discoveries in the Nile Delta and the eastern Mediterranean Sea. Natural gas reserves increased by nearly 70% in the last 3 years and represent nearly three-fifths of the country's total hydrocarbon reserves (Arab Oil and Gas Journal, 1997, p. 95).

Phosphate rock reserves are 1,270 Mt, iron ore reserves are 450 Mt, and manganese ore reserves total about 1.5 Mt.

Railways within Egypt totaled 5,110 km. There were more than 51,925 km of roadways and 1,171 km of crude oil pipelines. Installed electrical generation capacity was 14,000 megawatts divided among 37 thermal power stations and 4 hydroelectric plants. About 80% of the electrical output was generated by natural gas with the remainder generated by hydroelectric means. Egypt has embarked on a program that interconnects its power grid with neighboring countries. The first of these projects interconnected with the Libyan power grid in 1994. Plans include future Egyptian power grid connections with Jordan, Syria, and Turkey.

The allowance of 100% cost recovery on mineral-resource concession agreements should favor future foreign investment. The country is suffering from high levels of unemployment, and foreign investment and private sector development will be required if further progress is to be made. Private investment continues to make significant contributions in the mining and metallurgical segments of the Egyptian economy. Egyptalum reduced government equity in favor of private capital by 20%, while continuing its expansion program to raise annual smelter capacity to 240,000 t by 1997 from, 180,000 t. More natural gas fields than oil fields are under development. Three new Mediterranean nonassociated gas fields entered production in 1996, and two Western Desert fields are scheduled to enter production in 1997 and 1999. Coal exports are expected to begin in the near future.

## References Cited

Arab Oil and Gas Directory 1997, Egypt: Paris, Arab Petroleum Research Center, 624 pgs.

Energy Information Administration, 1997, International Petroleum Statistics Report: DOE/EIA-0520 (9706) (p. 40).

## Major Sources of Information

Egyptian Geological Survey and Mining Authority
3 Salah Salem Road
Abbassiya, Cairo, Egypt
Telephone: 20 (2) 831242, 831377
Fax: 20 (2) 820128

Egyptian General Petroleum Corp.
Osman Abdul Hadiz St.
Box 2130
Naser City, Cairo, Egypt
Telephone: 20 (2) 603899

Suez Canal Authority
Pilotage Bldg.
Ismailia, Egypt
Telephone: 20 (64) 5788350
Fax: 20 (64) 320784, 320785

Sumed Arab Petroleum Pipelines Co.
P.O. Box 158, El Sray
Alexandria, Egypt
Telephone: 20 (3) 5864138
Fax: 20 (3) 5871295

## TABLE 1
## EGYPT: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

| Commodity | | 1992 | 1993 | 1994 | 1995 | 1996 e/ |
|---|---|---|---|---|---|---|
| METALS | | | | | | |
| Aluminum metal | | 177,800 r/ | 178,477 r/ | 188,464 | 180,300 r/ | 176,700 |
| Chromite e/ | | 600 | 600 | 600 | 600 | 600 |
| Copper, refined, secondary | | 4,000 | 4,600 r/ | 4,300 r/ | 4,400 r/ | 4,400 |
| Iron and steel: | | | | | | |
| Iron ore and concentrate | thousand tons | 2,400 | 2,190 | 3,870 r/ | 2,043 r/ | 2,100 |
| Metal: | | | | | | |
| Pig iron | do. | 1,062 r/ | 1,325 r/ | 1,148 r/ | 1,062 r/ | 1,100 |
| Ferroalloys: Ferrosilicon | | 7,900 | 40,100 r/ | 40,000 e/ | 40,000 e/ | 40,000 |
| Direct Reduction | thousand tons | 826 | 837 | 774 | 850 | 830 |
| Steel, crude | do. | 2,524 | 2,772 | 2,622 | 2,642 | 2,618 |
| Ferromanganese e/ | | 10,000 | 30,000 | 35,000 | 35,000 | 35,000 |
| Ferrosilicon | | 36,038 | 40,136 | 44,000 | 44,000 | 44,000 |
| Manganese | | 11,000 | 15,000 | 15,000 e/ | 15,000 e/ | 15,000 |
| INDUSTRIAL MINERALS | | | | | | |
| Asbestos | | 373 | 604 | 514 | 427 r/ | 500 |
| Barite | | 7,841 | 2,535 | 419 | 500 r/ | 500 |
| Cement: Hydraulic | thousand tons | 17,000 | 16,000 | 17,000 r/ | 17,665 r/ | 18,000 |
| Clays: | | | | | | |
| Bentonite | | 4,215 | 4,994 | 2,379 | 1,930 r/ | 2,500 |
| Fire clay | | 475,000 | 421,000 r/ | 420,000 e/ | 420,000 e/ | 420,000 |
| Kaolin | | 203,473 | 184,004 | 180,000 | 293,381 r/ | 295,000 |
| Feldspar, crude | | 49,623 | 53,649 | 39,745 | 39,000 | 39,000 |
| Fluorspar | | 1,290 | 773 | 514 | 5,510 r/ | 800 |
| Gypsum and anhydrite, crude | thousand tons | 1,425 | 1,199 | 1,200 | 2,030 r/ | 0 |
| Ilmenite | | -- | -- | -- | 57,000 | 60,000 |
| Lime e/ | | 749,000 | 748,000 r/ | 750,000 | 750,000 | 750,000 |
| Nitrogen: Ammonia, N content | thousand tons | 943 | 941 | 900 e/ | 900 e/ | 900 |
| Phosphate: | | | | | | |
| Phosphate rock | do. | 2,000 | 1,590 r/ | 1,600 | 1,596 | 1,596 |
| $P_2O_5$ content | do. | 404 | 302 | 300 | 400 | 400 |
| Salt | do. | 1,096 | 986 | 1,008 | 1,990 r/ | 2,000 |
| Sodium compounds: | | | | | | |
| Soda ash | | 51,000 | 51,000 | 50,000 r/ | 50,000 e/ | 50,000 |
| Sodium sulfate | | 41,000 | 25,600 | 26,000 e/ | 26,000 e/ | 26,000 |
| Stone, sand and gravel: e/ | | | | | | |
| Basalt | thousand cubic meters | 1,000 2/ | 551 2/ | 600 | 600 | 600 |
| Dolomite | thousand tons | 900 | 952 | 1,000 | 1,000 | 1,000 |
| Granite, dimension | cubic meters | 10,000 2/ | 12,900 r/ 2/ | 13,000 | 13,000 | 13,000 |
| Gravel | thousand cubic meters | 11,000 2/ | 7,180 r/ 2/ | 7,200 | 7,200 | 7,200 |
| Limestone and other calcareous n.e.s. | do. | 18,000 2/ | 18,100 r/ 2/ | 18,000 | 18,000 | 18,000 |
| Marble blocks (including alabaster) | cubic meters | 57,000 2/ | 15,800 r/ 2/ | 16,000 | 45,000 | 45,000 |
| Sand: | | | | | | |
| Industrial sand (glass sand) | thousand tons | 500 2/ | 743 | 740 | 740 | 750 |
| Construction sand | do. | 26,000 2/ | 21,700 r/ 2/ | 22,000 | 22,000 | 22,000 |
| Sandstone | thousand cubic meters | 180 2/ | 180 | 200 | 200 | 200 |
| Sulfur: e/ | | | | | | |
| Elemental, byproduct | | 7,600 | 4,100 | 8,000 r/ | 10,000 r/ | 10,000 |
| Sulfuric acid | | 100,000 | 100,000 | 100,000 | 591,000 r/ | 680,000 |
| Talc, steatite, soapstone, pyrophyllite | | 8,908 r/ | 5,297 r/ | 4,125 r/ | 4,000 r/ | 4,000 |
| Vermiculite | | 463 | 942 | 1,659 r/ | 483 | 1,000 |
| MINERAL FUELS AND RELATED MATERIALS | | | | | | |
| Coke: Oven and beehive | thousand tons | 1,000 | 1,180 | 1,200 e/ | 1,200 e/ | 1,200 |
| Gas, natural: | | | | | | |
| Gross production | million cubic meters | 9,600 | 11,100 r/ | 11,900 r/ | 12,536 r/ | 14,000 |
| Dry e/ | do. | 8,000 | 8,800 r/ | 9,000 r/ | 9,500 r/ | 10,000 |
| Petroleum: | | | | | | |
| Crude | thousand barrels | 321,565 | 324,850 | 327,040 | 335,800 | 336,500 |
| Refinery products: | | | | | | |
| Liquefied petroleum gas | do. | 3,825 | 4,460 | 4,755 r/ | 5,325 r/ | 6,000 |
| Gasoline and naphtha | do. | 31,500 | 33,800 | 36,900 r/ | 38,450 r/ | 39,000 |
| Kerosene and jet fuel | do. | 18,400 | 18,750 | 17,155 r/ | 15,770 r/ | 19,000 |
| Distillate fuel oil | do. | 32,825 | 36,050 | 39,200 r/ | 43,550 r/ | 45,000 |
| Residual fuel oil | do. | 74,700 | 77,700 | 90,080 r/ | 80,350 r/ | 90,000 |
| Lubricants | do. | 1,440 | 1,400 | 1,580 r/ | 1,645 r/ | 2,000 |
| Asphalt | do. | 3,480 | 3,700 | 4,130 r/ | 4,485 r/ | 4,500 |
| Unspecified | do. | 2,375 | 2,430 | 2,250 r/ | 2,550 r/ | 2,600 |
| Total | do. | 168,545 | 178,290 | 196,050 r/ | 192,125 r/ | 208,100 |

e/ Estimated. r/ Revised.

1/ Table includes data available through Aug. 1, 1997.

2/ Reported figure.

TABLE 2

EGYPT: STRUCTURE OF THE MINERAL INDUSTRY FOR 1996

(Thousand metric tons unless otherwise specified)

| Commodity | Major operating companies and major equity owners | Location of main facilites | Annual capacity |
|---|---|---|---|
| Aluminum | Aluminium Co. of Egypt (Government, 80%; private interests, 20%.) | Nag Hammadi | 179 |
| Carbon black | Alexandria Carbon Black Co. (Egyptian Holding Co. for the Chemical Industry, 49%; Inco-Bharat, 36%, Grasim Industries 15%.) | Alexandria | 20 |
| Cement | Al Ameriyah Cement Co. | Ameriya | 2,100 |
| Do. | Asiut Cement Co. | Assiut | 2,600 |
| Do. | Helwan Portland Cement Co. (Government, 73%; private interests, 27%.) | Helwan | 2,800 |
| | | El Minya | 200 |
| Do. | Egyptian Cement Co. (Orascom Group, 40%; private interests, 40%; Holderbank Financiere Glaris Ltd., 20%) | 70 kilometers east of Cairo | 1,400 (completion 1998). |
| Do. | Suez Cement Co. (Government 77%; private interests, 23%). | Ain Sukhna | 1,700 |
| | | Qattamia | 1,200 |
| | | Waddi Hagoul | 1,200 |
| Do. | Alexandria Portland Cement Co. (Government 77%; private interests, 23%). | El Mex | 800 |
| Do. | National Cement Co. (Government 77%; private interests, 23%). | El Tabbin | 4,000 |
| | | Beni Suef | 1,000 |
| Fertilizers, nitrogenous | Société El-Nasr d Engrais et d'Industries Chemiques (Government, 100%) | Abu Qir | 660 (ammonia ). |
| | | | 760 (ammonia nitrate). |
| Do. | do. | Suez | 146 (ammonia). |
| | | | 450 (nitric acid). |
| | | | 365 (ammonium nitrate). |
| Do. | do. | Talkha | 330 (ammonium nitrate). |
| | | | 570 (ammonia & urea). |
| Do. | Egyptian Chemical Industries (Government, 100%) | Kimi | 330 (ammonia). |
| | | | 600 (nitric acid). |
| | | | 800 (ammonium nitrate). |
| Iron and Steel | Egyptian Iron and Steel Co. (Government, 100%) | Helwan steel plant | 1,500 |
| Do. | Alexandria National Iron and Steel Co. (Government, 100%) | El Dikheila plant | 1,100 |
| Natural gas million cubic meters | Egyptian General Petroleum Corp. (EGPC) (Government, 100%) | Abu Madi | 3,800 |
| | | Badreddin- 3 | 3,000 |
| | | Abu Qir/Naf | 1,900 |
| | | Ras Shukheir | 1,600 |
| Do. do. | Grupo Khalda (Repson, 50%, Apache Oil Co., 40%; Samsung, 10%). | Khalda | 24 |
| Petroleum, crude million 42-gallon barrels | Gulf of Suez Oil Co. (EGPC , 50%; Amoco, 50%) | October, Suez Gulf | 45 |
| | | El Morgan, Suez Gulf | 27 |
| Do. do. | Belayim Petroleum Co. (EGPC, 50%; IEOC, 50%) | Belayim, Suez Gulf | 65 |
| Do. | Suez Oil Company (EGPC, 50%; Deminex, 25%; Repsol, 25%) | Ras Budran, Suez Gulf | 15 |
| Petroleum, pipeline million 42-gallon barrels | Arab Petroleum Pipeline Co. (Egypt, 50%; Saudi Arabia, 15%; Kuwait, 15%; United Arab Emirates, 15%; Qatar, 5%) | Ain al-Sokhna to Sidi Kir | 875 |
| Petroleum, refined | Cairo Petroleum Refining Co. (Government, 100%) | Mostorod | 42 |
| | | Tanta | 15 |
| Do. do. | Alexandria Petroleum Co. (Government, 100%) | Alexandria | 42 |
| Do. do. | El-Nasr Petroleum Refining Co. (Government, 100%) | Suez | 36 |
| Do. do. | Ameriya Petroleum Refining Co. (Government, 100%) | Ameriya | 27 |
| Do. do. | Suez Petroleum Processing Co. (Government, 100%) | Suez | 21 |
| Do. do. | Asyut Petroleum Refining Co. (Government, 100%) | Asyut | 18 |
| Phosphate rock | Egyptian Organization of Industrial and Mining Complexes (Government, 100%) | Abu Tartur | 2,200 |

### THE MINERAL INDUSTRY OF

# ERITREA

### By Philip M. Mobbs

Eritrea became an independent nation on May 24, 1993. The 125,000-square-kilometer country, bordering the Red Sea in northeast Africa, had an agriculture-based economy. The minerals industry was not yet a significant factor in the economy of Eritrea, however, the Government was making an effort to attract foreign investors and was especially interested in the potential enhancement that the mining and petroleum sectors could provide to the economy. To that end, several minerals-related laws have been issued since independence. A petroleum operations code was issued in July 1993; a general investment code was issued in 1994; and the Mining Proclamation No. 68/1995, the Mining Income Tax Proclamation No. 69/1995, and Regulations on Mining Operations Legal Notice 19/1995 were issued in March 1995. Royalties were 5% on precious metals and 3.5% on other minerals, the mining income tax rate was 38%, and there was no export tax on minerals.

The Geological Survey, within the Ministry of Energy, Mining and Water Resources' Department of Mines, had assembled and maintained a historical exploration and mining data base. The Ministry had defined prospect areas and awarded mineral property licenses in the central and northern regions to 6 of the 20 companies had reportedly applied for licenses during the First Round of licensing in September 1995 (Kensington Publications, 1996). Seven exploration and six prospecting licenses were assigned to the First Round license holders. Ashanti Goldfields Co. Ltd. of Ghana obtained licenses in the Ketina and the Medrezien areas; La Source of France secured the Adi Nefas concession; Pan African Resources Corp. of Canada acquired the Galla Valley license; Phelps Dodge Exploration Corp. of the United States gained exploration rights; Rift Resources Ltd. of Canada, through its Eritrean-Timmins Resource Ventures plc subsidiary, was exploring in the Ketina area and prospecting on the Nefasit-Mount Subul property; and WMC (Overseas) Pty. Ltd. of Australia received the exploration rights to properties in the Debub region and the Semenawi Keyih Bahri area. The Ministry planned a Second Round of licensing for early 1997 (Ministry of Energy, Mines and Water Resources, 1997).

Anadarko Petroleum Corp. of the United States was working on the Zula block offshore in the Red Sea. The Ministry was negotiating with other petroleum companies interested in exploring in Eritrea.

The country's mineral facilities included an 18,000-barrel-per-day petroleum refinery at Assab that was owned by the Eritrean Government and operated by Ethiopian Petroleum Corp. and a 45,000-metric-ton-per-year (t/yr) cement plant at Massawa, the country's main Red Sea port, with associated quarries for limestone, clay or shale, and gypsum. The Orota Iron and Steel Plant commissioned a 60,000-t/yr rolling mill during 1996 and was installing a 7,000-t/yr electric arc furnace. In addition, there were solar-evaporation sea salt plants near Massawa and Assab, each said to have capacities of more than 100,000 t/yr; quarries for dimension stone (granite and marble); and sources of silica sand and other raw materials for a 20-metric-ton-per-day glassworks in Asmara. Numerous artisanal gold workings were south and southwest of Asmara, and small quantities of lignite were mined at Adi Ugri, 50 kilometers (km) south of Asmara. The Government reported a 65% increase in gold production, to 98 kilograms (kg) compared with 59 kg in 1995.

Additional mineral occurrences having some potential for development included a beryl-bearing pegmatite at Shiliki, many primary gold deposits in quartz veins and schists of the Precambrian terranes west of Asmara, seven documented iron deposits east and south of Asmara, kaolin at several sites, and a nickel-chromite deposit in the northwest near the Sudanese border. Other mineral occurrences include petroleum along the mostly desert coastal plain and in the Dahlak Islands offshore of Massawa, potash in the Danakil Depression southeast of Asmara, and salt on the Dahlak Islands (Wegner and Häußer, 1996).

The nation's infrastructure, which suffered severe damage from the 30-year Ethiopian civil war that ended in 1991, was being rehabilitated with financial assistance from a number of countries in the European Union. Unexploded ordnance and land mines still litter the countryside. The 308-kilometer (km) railroad from Ak'orda through Asmara to Massawa was being rebuilt, only about 20 km of track inland from Massawa was operational. The ports at Assab and Massawa were being renovated.

Eritrea was suffering from a severe energy shortage. The nation had approximately 60-megawatts (MW) of electrical generating capacity, fueled by imported diesel. An 84-MW diesel powerplant was proposed for Hirgigo, near Massawa, and the installation of a 4-MW diesel-fueled generator was planned for Massawa. In 1996, the U.S. Geological Survey began an investigation of geothermal power southeast of Zula Bahir Selat'ē.

More exploration activity appeared to be likely as the Government authorizes additional mining and petroleum leases. The demand for construction and industrial materials is not expected to abate during this century, given the extensive rebuilding anticipated.

#### References Cited

Kensington Publications, 1996, Meeting the energy crisis: Kensington

Publications, United Kingdom [Accessed August 4, 1997, on the World Wide Web at URL http://www.kenpubs.co.uk/worldstatesmen/Archive/Ghebreslasie.html]

Ministry of Energy, Mines and Water Resources, 1997, Mineral prospects of the State of Eritrea: Ministry of Energy, Mines and Water Resources, Asmara, Eritrea, February 6, 1997, 10 p.

Wegner, Hans-Ulrich, and Häußer, Ilse, 1996, Eritrea: Hannover/Berlin, Bundesanstalt für Geowissenschaften und Rohstoffe, Rohstoffwirtschaftliche Länderberichte XL, 41 p. [In German.]

## Major Source of Information

Ministry of Energy, Mining and Water Resources
P.O. Box 5285
Asmara, Eritrea
Telephone: (291) (1) 124-271
Fax: (291) (1) 122-185

### TABLE 1
### ERITREA: PRODUCTION OF MINERAL COMMODITIES 1/ 2/

(Metric tons unless otherwise specified)

| Commodity | | 1992 | 1993 | 1994 | 1995 | 1996 |
|---|---|---|---|---|---|---|
| Basalt | | XX | XX | 114,483 | 233,555 | 509,300 |
| Cement | | XX | XX | 45 000 r/ e/ | 49 947 r/ | 47 031 |
| Clays: | | | | | | |
| Common | | XX | XX | 62,970 | 88,676 | 81,600 |
| Kaolin | | XX | XX | 5,231 | 3,200 r/ | 2,620 |
| Coral | | XX | XX | 74,404 | 78,603 | 69,269 |
| Feldspar | | XX | XX | 6,823 | -- | -- |
| Gold | kilograms | XX | XX | 78 | 59 | 98 |
| Granite | | XX | XX | 43,803 | 82,007 | 130,000 |
| Gravel | | XX | XX | 80,622 | 1,172,500 r/ | 11,715 |
| Gypsum | | XX | XX | 15 | 20 | 23 |
| Lime | | XX | XX | 6,294 | 6,955 | 7,000 e/ |
| Limestone e/ | | XX | XX | 60,000 r/ | 70,000 r/ | 80,000 |
| Marble 3/ | | XX | XX | 190 | 292,400 r/ | 218,300 |
| Pumice | | XX | XX | 183 | 233 | 300 e/ |
| Quartz | | XX | XX | 488 | 276 | 870 |
| Salt | | XX | XX | 207,836 | 254,700 | 200,412 |
| Sand | | XX | XX | 464,883 | 911,508 | 1,000,000 e/ |
| Silica sand | | XX | XX | 38,014 | 966,200 r/ | 1,481 100 |
| Talc | | XX | XX | 3 | -- | -- |
| Petroleum products | thousand 42-gallon barrels | XX | XX | 5,150 | 4,336 | 4,500 |

e/ Estimated. r/ Revised. XX Not applicable.

1/ Includes data available through Aug. 6, 1997.

2/ Eritrea became independent in May 1993. Prior production reported under Ethiopia.

3/ In addition to tonnage listed in this table, 108,545 square meters of marble were produced for the construction industry in 1995.

## THE MINERAL INDUSTRY OF

# ETHIOPIA

### By Philip M. Mobbs

The minerals industry was a minor contributor to Ethiopia's economy in 1996, although there was increasing foreign investor activity in the sector. Gold was the most significant mineral export whereas fertilizer and petroleum products were the most significant mineral imports. Construction materials—including brick clay; limestone and shale mined for cement production; gypsum for cement and plaster; sand and gravel; crushed and dimension stone—were also important Ethiopian mineral commodities. A variety of other minerals were also produced. (*See table 1.*) Additional minerals, such as lignite, natural gas, phosphate, and potash are known to occur in deposits of potentially economic size and grade in various parts of the country (Ministry of Mines and Energy, undated).

A mountainous high plateau in the northwestern half of the country was capped mostly by thick Tertiary basalt flows rather barren of valuable mineral deposits. But Precambrian basement, hosting many metallic and industrial mineral resources, was exposed in river gorges and along the edges of the basalt cap, particularly in the far northern highlands and in the western and southern lowlands. Drainage, with high potential for hydroelectric power, was mostly westward into the Nile River system. Splitting the country about in half, a major rift valley extended southwesterly from Djibouti in the northeast to Lake Turkana in the southwest. That valley was the locale for a number of evaporite and other industrial mineral deposits, salt lakes, and geothermal sources. The eastern one-third of the country, mainly covered by Mesozoic sediments, offered construction materials sources and oil and gas targets. Oil and gas evidence also was found in the southwestern lowlands near the Sudan.

The Government was actively promoting further mineral development. Mining Proclamation 52/1993 and the Mining Income Tax Proclamation 53/1993 were designed to offer competitively attractive terms to international investors. The Mining Operations Council of Ministers Regulation No. 182/1994 expanded on Mining Proclamation 52/1993 (Wegner and Häußer, 1996). An investment promotion document on Ethiopian minerals, country and economic information, and geology and mining was issued late in 1994 by a U.S. consulting firm under contract with the Government and funded by the United Nations (U.N.). (Techno-Economic Consulting, Inc., 1994). The Investment Proclamation of June 1996 replaced decree 15/1984. During 1996, the House of Representatives amended Mining Proclamation 52 and Mining Income Tax Proclamation 53. Mining income tax was reduced to 35% compared with 45% under the original proclamation. The Government also reduced its free carried interest in mineral operations to 2% compared with up to 10% free carried interest formerly allowed. Mining operations were subject to national and regional governmental approval.

Environmental impact studies were required for submittal with applications for exploration and exploitation concessions. Pollution controls and site restoration plans had to be specified in applications.

Under the former Government's central planning, most larger industrial enterprises were state-owned. Enterprise privatization was proceeding more slowly than the opening of the mineral sector to new private investors. One state-owned company that was very active was the Ethiopian Mineral Resources Development Corp. (EMRDC). It operated the Lega Dembi gold mine about 350 kilometers (km) south of Addis Ababa, which had a capacity for producing 3,000 kilograms per year (kg/yr) of gold ingot with about one-half coming from a gravity plant and the rest from a tank-leach-electrowinning plant. EMRDC ran the Kenticha open pit columbite-tantalite mine and pilot plant, approximately 50 km southeast of Lega Dembi, with an output capacity of 20 metric tons per year (t/yr) of concentrate. The Adola Gold Development Enterprise, a section of EMRDC, managed a smaller placer gold mining operation in the Adola region east of Lega Dembi, producing about 300 kg/yr. As part of the Lakes Soda Ash Development Project, EMRDC operated a 20,000-t/yr soda ash plant at Lake Abijata in the rift valley about 125 km south of Addis Ababa. EMRDC also had projects for developing gemstone deposits and industrial minerals to support a ceramics industry.

The Ethiopian Institute of Geological Surveys continued regional mapping of the country and was studying the nation's base metals, feldspar, gold, iron, kaolin, phosphate, and potash resources.

At yearend, the state-owned Zuqualla steel rolling mill at Debreiziet, 80 km south of Addis, was installing a 100,000-t/yr mill. Cement plants at Addis Ababa, Dire Dawa, and Muger (the last two about 360 km east-northeast and 60 km northwest of Addis Ababa, respectively) were units of the state-owned Ethiopian Cement Corp. Kiln output capacities were indicated as being about 50,000; 20,000; and 600,000 t/yr, respectively. Grinding capacities were higher.

Privately owned operations that mostly were producing construction materials ranged from local sand and gravel pits to export-oriented dimension stone quarries at various sites. However, gold production (1,500 kg/yr) was attributed to artisanal operations in the north and west, as well as in the south.

More than 25 companies had active prospecting licenses. Gold headed the list of mineral commodities attracting investment attention during 1996. Behre Dolbear & Co. Inc. of the United States was facilitating the privatization of the Lega Dembi gold mine. The open pit operation in the southern part of the country had began operations in 1991. Thirteen offers were reportedly submitted (Ethiopian News, 1997), including bids by Canyon Resources Africa Ltd., a subsidiary of Canyon Resources Corp. of the United States, and joint-venture partner JCI Ltd. of South Africa; the HRC Development Corp. of Canada and Inmet Mining Corp. of Canada joint venture; National Mining Corp. of Saudi Arabia; and the Canadian joint venture of Rift Resources Ltd. and Echo Bay Mines.

The joint venture between Ashanti Goldfields Co. Ltd. of Ghana and Ezana Mining Development plc of Ethiopia was sampling soil on the Hawsen and Shire prospects in northern Ethiopia (Tigray). Ezana Mining was owned by the Tigray regional government. Canyon Resources and JCI were exploring the Megado Serdo license area in southern Ethiopia, near the Lega Dembi Mine. Canyon Resources and JCI also acquired the exploration license for the Meleka Adeba property.

Emerging Africa Gold Inc., a subsidiary of Ste. Geneviève Resources Ltd. of Canada, acquired two permits in the western highlands, the Sirkole gold concession and the Yubdo platinum concession. International Roraima Gold Corp. of Guyana acquired Roraima Mining Co.'s four exploration licenses on the Koko Kenticha property in southern Ethiopia. Iscor Ltd. of South Africa had the option to earn 55% interest in the Koko Kenticha gold licenses.

National Mining Corp. was exploring on its gold exploration licenses at Dawa-Digati and Okote in southern Ethiopia. Pan African Resources Corp., a subsidiary of Golden Star Resources Ltd. of Canada, was drilling and trenching on the Dul prospect in western Ethiopia.

Rift Resources Ltd. of Canada completed its initial exploration programs on the Negele-Bul Bul gold license area, approximately 500 km south of Addis Ababa, and on the Humera gold prospect, approximately 600 km north-northeast of Addis Ababa. In December 1996, Rift acquired a gold exploration license for the Moyale concession, approximately 600 km south of Addis Ababa on the Kenya border. Rift also proposed to work in a joint venture with Ezana Mining on four properties in the north and the west. Tan Range Exploration Corp. of Canada acquired precious metals exploration rights to the Hageremariam, the Tulu Dimtu, and the Tulu Kapi licenses. Asteria of Italy reportedly obtained an exploration license near Babile (Africa Energy & Mining, 1996).

Petroleum exploration concessions in effect included International Petroleum Corp. in the west on the Sudan border and Hunt Oil Co. in the south. The Ethiopian Oil & Natural Gas Exploration & Development Organization operated the 18,000-barrel-per-day refinery in Assab, Eritrea. Ethiopia received 80% of the refinery's output. The Calub Gas Development Share Co., having national and local governments as well as private individuals as shareholders, was proceeding with development of motor and household fuels production from the Calub Gasfield in the Ogaden region in the southeast.

The physical infrastructure had limitations, primarily associated with war damage. Roads from Addis Ababa to the Red Sea Port of Assab, Eritrea (about 1,000 km), carried almost 90% of landlocked Ethiopia's exports. The Government encouraged increased utilization of the railroad from Addis Ababa to the Red Sea Port of Djibouti (about 750 km). The Chemin de Fer Djibouto-Ethiopien, which had formerly been a major regional transportation link, was operated as a joint venture by the Djiboutian and Ethiopian Governments. During 1996, rehabilitation of rail operations was the subject of a study by a joint government commission.

Ethiopia's electrical generating capacity of 371 megawatts (MW) was of limited availability outside urban areas, but the Government proposed new generation (385 MW) and distribution facilities. A pilot plant to evaluate geothermal electricity generation near Lake Langano, about 150 km south of Addis Ababa, was announced during 1995 (Africa Economic Digest, 1995).

Water was generally available from river or ground water sources in the minerals-rich areas. Telecommunications were reported reasonably adequate internationally and between regional centers with improvements and expansions planned.

The outlook was for increased activity by domestic and international minerals companies, eventually resulting in increased utilization of Ethiopia's considerable resources.

## References Cited

Africa Economic Digest, 1995, Geothermal resources discovered: Africa Economic Digest, London, November 20, v. 16, no. 24, p. 12.

Africa Energy & Mining, 1996, Ethiopia—New mining licence: Africa Energy & Mining, Paris, July 10, no. 185, p. 8.

Ethiopian News, 1997, Saudi financier to operate Ethiopian gold mine: Ethiopian News, July 19. (Accessed August 6, 1997, on the World Wide Web at URL http://www.ethio.com).

Ministry of Mines and Energy, undated, Geology, mineral occurrences, mining policy and investment opportunities in Ethiopia: Ministry of Mines and Energy, Addas Ababa, Ethiopia, 24 p.

Techno-Economic Consulting, Inc., 1994, Introducing the mineral wealth of Ethiopia, United Nations Department of Development Support and Management Services, New York, 19 p.

Wegner, Hans-Ulrich, and Häußer, Ilse, 1996, Ãthiopien: Hannover/Berlin, Bundesanstalt für Geowissenschaften und Rohstoffe, Rohstoffwirtschaftliche Länderberichte 39, 103 p. (In German.).

## Major Sources of Information

Ministry of Mines and Energy
P.O. Box 486
Addis Ababa, Ethiopia
Telephone: 251-1-518250
Fax: 251-1- 614574
Ethiopian Institute of Geological Surveys
P.O. Box 2302
Addis Ababa, Ethiopia
Fax: 251-1-513877

## Major Publication

Techno-Economic Consulting, Inc., 1994, Mineral Investment Opportunities in Ethiopia, v. 1, country and economic information and v. 2, geology and mining: Techno-Economic Consulting, Inc., New York.

## TABLE 1
## ETHIOPIA: ESTIMATED PRODUCTION OF MINERAL COMMODITIES 1/ 2/

(Metric tons unless otherwise specified)

| Commodity | | 1992 | 1993 | 1994 | 1995 | 1996 |
|---|---|---|---|---|---|---|
| Cement, hydraulic | | 320,000 | 350,000 | 464,396 3/ | 611,437 3/ | 700,000 |
| Clays: 4/ | | | | | | |
| Brick | | 15,000 | 15,000 | 10,000 | 7,000 | 7,000 |
| Kaolin (China clay) | | 420 | 500 | 8 r/ | 15 r/ | 15 |
| Diatomite | | 5 | 10 | 150 3/ | 150 3/ | 150 |
| Feldspar | | 10,000 | 10,000 | 4,000 | 4,000 | 4,000 |
| Gold, mine output, Au content | kilograms | 2,224 | 3,387 | 2,370 | 4,500 3/ | 2,500 |
| Gypsum and anhydrite, crude | | 2,650 | 2,500 | 30,700 | 124,000 r/ 3/ | 124,000 |
| Lime | | 100 | 100 | 2,727 r/ 3/ | 3,091 r/ 3/ | 3,100 |
| Petroleum refinery products | thousand 42-gallon barrels | 2,530 3/ | 4,000 | -- | -- | -- |
| Platinum, mine output, Pt content 5/ | grams | 500 | -- | -- | 100 r/ | 100 |
| Pumice 4/ | | 49,000 | 40,000 | 127,000 | 360,000 | 360,000 |
| Salt: | | | | | | |
| Marine | | 100,000 | 120,000 | -- | -- | -- |
| Rock | | 10,000 | 10,000 | 5,000 | 5,000 | 5,000 |
| Scoria | | 8,000 | 8,000 | 190,000 r/ | 240,000 r/ | 250,000 |
| Soda ash, natural | | 500 | 248 3/ | 2,150 3/ | 20,000 3/ | 20,000 |
| Stone, sand and gravel: 4/ | | | | | | |
| Construction stone, crushed | thousand tons | 860 | 1,000 | 300 | 750 | 750 |
| Dimension stone 6/ | | 2,000 | 3,000 | 42,000 | 38,000 | 38,000 |
| Limestone 7/ | thousand tons | 100 | 100 | 700 | 3,215,000 | 3,300,000 |
| Sand 8/ | do. | 700 | 1,000 | 6,040 | 1,600 | 1,600 |
| Silica sand | | 40,000 | 40,000 | 5,000 | 6,000 | 6,000 |
| Tantalite, concentrate (40% $Ta_2O_5$) | | 14 | 17 3/ | 26 3/ | 20 3/ | 20 |

r/ Revised.

1/ Data are for year ending July 7 of the year listed. For 1993, some production (particularly cement and component limestone, shale or clay, gold, gypsum, petroleum refinery products, salt, and stone) may be in Eritrea, which became independent in May 1993.

2/ In addition to the commodities listed, some lignite and semiprecious gemstones reportedly were produced, and silver was reportedly contained in gold ingots from the Lege Dembi Mine, but information is inadequate to reliably estimate output.

3/ Reported figure.

4/ When reported as volume or pieces, conversions to metric tons are estimated.

5/ No platinum production was officially reported after 1988. However, some artisanal platinum probably continued to be produced, and platinum was also reported by others as being contained in gold ingots from the Lege Dembi gold mine, which started up in 1990; but information is inadequate to reliably estimate output.

6/ Includes marble.

7/ Apparently does not include production for cement manufacture for 1992-94. Normally, the manufacture of 1 ton of cement requires 30 to 50 kilograms of gypsum as well as 1.3 to 1.8 tons of limestone and up to 0.5 ton of shale and/or clay.

8/ May include gravel.

## THE MINERAL INDUSTRY OF

# GABON

### By Thomas S. Jones

In 1996, mineral resources played a key role in the economy of Gabon, which for African countries had a comparatively high per capita gross domestic product (GDP). Gabon's mineral economy continued to be dominated by the oil sector, which has been accounting for about three-quarters of total export revenues, one-half of Government revenues, and one-third or more of GDP. Nonfuel minerals, chiefly manganese and uranium, have been contributing about 2% to GDP. *(See table 1.)*

Oil export revenues of more than $2 billion represented nearly 80% of total 1996 export revenues. The 50% of Gabon's petroleum exports that went to the United States represented 2.5% of U.S. crude imports. By value, Gabon's next most important export commodities were, in descending order, wood, manganese, and uranium.

Almost one-half of Gabon's imports were equipment, machinery, and manufactured goods destined to support the petroleum and mining sectors. France provided a significant proportion of imports.

Establishment of a new mining code was under consideration by the Government. Pending its replacement, the basic mining law of Gabon was the 1962 Mining and Petroleum Code, law 15/62, as modified in 1968 by law 16/68 and in 1970 by Decree No. 981. The mining fiscal regime is now governed by Ordinance No. 38/79/PR. Petroleum exploration and exploitation were further regulated by laws 14/74 and 14/82. The Ministère des Mines, de l'Energie et du Petrole administered the mineral industry. Mineral concession contract terms emphasized spending commitments by private companies. Crude petroleum production-sharing agreements provided for Government participation as a joint-venture partner, in addition to a royalty of 20%. The Gabonese environmental law, law 16/93 Relating to the Improvement and Protection of the Environment, contained a section that addresses mining and petroleum activities. The Direction Générale de l'Environnement was responsible for environmental oversight.

The Government had a share in nearly every mineral venture, which, for those listed in table 2, ranged from 25% to more than 90%. *(See table 2.)* The Government, however, was seeking to diversify its partnership mix by soliciting new international participants. Among foreign companies active in Gabon's mineral industry, many were subsidiaries of French companies, and several U.S. firms were active in petroleum exploration.

The most important infrastructure unit in Gabon was the 649-kilometer (km)-long Trans-Gabon Railway, operated by the Government's Office du Chemin de Fer Transgabonais (OCTRA), that linked Franceville in the southeast with the Atlantic coast port of Owendo. The railroad, an agent for mineral and industrial development, was used for shipping cement clinker, equipment, fuel, manganese, uranium, and wood logs. OCTRA, as well as Société d'Electricite de d'Eau du Gabon, the national electricity and water monopoly, was scheduled for privatization under the provisions of a law that became effective in February 1996. This law was in response to conditions that had been established by the International Monetary Fund. Gabon's petroleum pipeline infrastructure was particularly well developed and fed coastal loading terminals at Cap Lopez near Port Gentil and Gamba to the southwest.

Crude oil production increased in 1996 to an average rate of 368,000 barrels per day (bbl/d), thus continuing the trend begun in 1987. The 1996 output was above the quota of 287,000 bbl/d set by the Organization of Petroleum Exporting Countries (OPEC), which Gabon had joined in 1975. Gabon left OPEC in mid-1996 because of dissatisfaction with its flat-rate dues structure. Gabon viewed OPEC's policy as discriminatory toward smaller producers and had argued for a fee based on a member's production.

Petroleum was produced by three companies, in order of decreasing output, Shell Gabon of the Netherlands, Elf Gabon of France, and Perenco Plc. (formerly Kelt Energy Plc.) of the United Kingdom. Shell Gabon accounted for about three-fifths of Gabon's total production, mainly from the onshore Rabi-Kounga field, the interests in which were divided between Shell Gabon, 42.5%; Elf Gabon/Société National Elf Aquitaine Group, 47.5%; and Amerada-Hess Production Gabon Inc., 10%. Elf Gabon accounted for somewhat more than one-third of total production, mainly from the offshore Anguilee/NE/SE, Hylia, and Torpille/NE fields and the onshore Avocette and Coucal fields. Perenco's production was about 7% of the country's total.

In 1996, 7 exploratory wells and 22 development wells were drilled in Gabon. Production-sharing contracts with the state were a standard feature of new petroleum exploration and development activities. Contracts for offshore sites included those with Amoco Gabon BV and Phillips Petroleum Gabon Ltd. for exploration of the Gryphon Marin block off southern Gabon, Arco International Oil and Gas for the deep offshore block D-93 of the Tolo license, Elf Gabon for the Akori and the Sika blocks, Marathon Oil Co. (Marathon Petroleum Akoumba Ltd. unit) for the Akoumba Marin tract in the North Gabon Basin, and Shell Gabon for the Kenguérié and Bam-Bam areas between Libreville and Port Gentil. Contracts for onshore sites included those with Canada's Chauvco Resources Ltd. for the Remboué concession, Elf Gabon for the Mikoumé and Mpaga blocks, Canada's Ocelot Energy Inc. for the Panthere-Nze and M'Bindji permits, and Shell Gabon for the Inéka block near Port Gentil. A contract of the Santa Fe Energy Resources of Gabon unit of Santa Fe Energy Resources Inc. was for the Mondah Bay block, which included onshore and offshore areas, north of Libreville.

As of January 1, 1997, Gabon had 1.34 billion barrels of proven oil reserves and 14,000 million cubic meters ($m^3$) of natural gas (Oil & Gas Journal, 1997). Most of Gabon's production of natural gas was flared or reinjected for reservoir pressure maintenance. Of 2,600 million $m^3$ of gross production in 1994, 1,800 $m^3$ was flared, 600 $m^3$ was reinjected, and only about 200 million $m^3$ was marketed, mostly for use in electricity generation or as a refinery fuel.

Among nonfuel minerals, diamonds were produced by artisanal miners mostly at Monkongonio in the south of the country. Diamond occurrences are widespread in Gabon but concentrations are generally low.

Gold production also was by artisanal miners, almost all through the handworking of relatively small placer and eluvial deposits at sites such as Etéké, Kolissen, Makokou, Mitzic, Ndangui, and Ndjolé. Canada's Golden Star Resources Ltd., through its Pan African Resources Corp. (PARC) subsidiary, was one of the more active among foreign firms exploring for gold in Gabon. PARC, however, discontinued its efforts on the Etéké license because it was not able to identify a sufficiently promising prospect (Golden Star Resources Ltd., 1997).

Manganese ore was produced by Compagnie Minière de l'Ogooué S.A. (Comilog) by open pit methods from a number of zones on the Bangombé Plateau at Moanda. The ore produced typically contained 51% manganese, including high-grade ore (48% to 52% manganese) for metallurgical and hydrometallurgical uses and battery-grade ore (82% to 85% manganese dioxide). All marketable product was exported via shipment to the port of Owendo on the Trans-Gabon Railway using Comilog locomotives and rolling stock. According to Gautier (1997), of total manganese resources on four plateaus near Moanda a reserve volume of 250 million metric tons (Mt) was considered to be proven and corresponded to 130 Mt of marketable concentrates. As has historically been the case, a significant proportion of Comilog's ore output went to Société du Ferromanganèse de Paris-Outreau in France. In June, France's Eramet Group formally completed its acquisition of a total of 46% of Comilog's shares. By thus becoming the largest shareholder, Eramet took over management of Comilog. Eramet and Comilog subsequently initiated a restudy of the feasibility of establishing a ferromanganese smelter in Gabon. In contrast to a previous study of this possibility, the latest study focused on siting a plant near the mine. Coal shipped there as backhaul in otherwise empty ore cars was a possible fuel for the plant.

Uranium was mined in the southeast at Mounana in Haut Ogooué Province by Compagnie des Mines d'Uranium de Franceville (Comuf). Comuf was one of the world's smaller producers, and exported most of its output to France.

Deposits of other minerals having the possibility of commercial exploitation included those of barite, iron ore, and phosphate. Of these, extraction of phosphate from the Mabounié carbonatite complex near Lambaréné in the west-central portion of the country appeared closest to commercialization. This was a project of the Société Minière du Moyen Ogooué consortium, of which the Government owned 62%. From a geological resource of 140 Mt containing 24% $P_2O_5$, it was projected that a production of 2 million metric tons per year of concentrate containing about 39% $P_2O_5$ could be obtained for at least 20 years. The most likely method of transporting product to market appeared to be a slurry pipeline from Mabounié to Lambaréné and then river transport to Port Gentil. Recovery of a niobium coproduct also was under study. In southwestern Gabon, a barite deposit at Dourekiki, assessed as containing more than 3 Mt, had an average grade of 46% $BaSO_4$ and included an enriched zone with an average grade of 65% $BaSO_4$. If developed, this deposit could supply a high density ingredient of mud used in drilling oil wells. Iron ore deposits are located in the Makokou area of northeastern Gabon; the deposit at Belinga is the most important. On the basis of exploration done in the 1970's, resources have been assessed at 566 Mt with an iron content of 64%. Development of the deposit was dependent on building a rail connection from Bélinga to Booué, a distance of about 230 km.

Gabon, therefore, has some potential to enlarge its mineral sector, but its immediate future for minerals hinges, as in the recent past, on manganese, petroleum, and uranium. Petroleum is expected to continue to account for a significant proportion of the Nation's economy, which thus remains highly susceptible to fluctuations in oil demand and prices. The Nation's manganese industry could expand if a smelter is established. Uranium production could, however, end soon because of market conditions.

### References Cited

Gautier, R.P., 1997, The Cie. Minière de l'Ogooué: Skillings Mining Review, v. 86, no. 16, p. 4-13.

Golden Star Resources Ltd., 1997, Annual report 1996: Denver, Golden Star Resources Ltd., 78 p.

Oil & Gas Journal, 1997, Worldwide look at reserves and production: Oil & Gas Journal, v. 95, no. 52, December 29, p. 39.

### Major Publications

Adloff, L.R., 1996, Information for the mining investor in Gabon: Libreville, Ministère des Mines, de l'Energie et du Petrole, 184 p.

Marchés Tropicaux et Méditerranéens, 1996, Entreprendre au Gabon: Marchés Tropicaux et Méditerranéens, November, 80 p.

SBC Warburg, 1997, Republic of Gabon: [London], SBC Warburg, July, 44 p. [In English, 44 p.; in French, 44 p.].

## TABLE 1
## GABON: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

| Commodity 2/ | | 1992 | 1993 | 1994 | 1995 | 1996 e/ |
|---|---|---|---|---|---|---|
| Cement: | | | | | | |
| Clinker | | 116,000 | 132,398 | 125,609 | 140,845 | 142,000 |
| Cement, hydraulic 3/ | | 138,381 | 141,283 | 147,798 | 153,953 | 155,000 |
| Diamond, gem and industrial e/ | carats | 500 | 500 | 500 | 500 | 500 |
| Gas, natural, gross 4/ | million cubic meters | 155 | 153 | 129 | 150 e/ | 150 |
| Gold, mine output, Au content e/ 5/ | kilograms | 70 | 120 | 72 | 70 r/ | 70 |
| Manganese: | | | | | | |
| Metallurgical-grade ore, gross weight (50% to 53% Mn) 6/ | | 1,455,000 | 1,257,000 r/ | 1,366,000 e/ | 1,844,000 r/ e/ | 1,933,000 |
| Pellets, battery- and chemical-grade, gross weight (82% to 85% $MnO_2$) | | 101,000 | 33,000 r/ | 70,000 e/ | 86,000 r/ e/ | 50,000 |
| Total 6/ | | 1,556,000 | 1,290,000 | 1,436,000 | 1,930,000 | 1,983,000 |
| Petroleum: | | | | | | |
| Crude 7/ | thousand 42-gallon barrels | 107,000 | 114,000 | 126,000 | 133,000 | 134,000 |
| Refinery products | do. | 6,200 r/ | 5,800 r/ | 6,900 r/ | 6,900 r/ | 6,900 |
| Uranium, content of concentrate | | 545 r/ | 592 | 589 | 653 r/ | 623 8/ |

e/ Estimated. r/ Revised.

1/ Table includes data available through February 4, 1998.

2/ In addition to the commodities listed, a variety of crude construction materials (clays, sand and gravel, and stone) is also produced, but output is not reported and available information is inadequate to make reliable estimates of output levels.

3/ Includes cement produced from imported clinker.

4/ Does not include gas flared or reinjected into reservoirs for repressuring.

5/ Gold production figures do not include production smuggled out of the country, which in recent years was estimated to exceed 400 kilograms per year.

6/ Data are rounded to four significant digits.

7/ Reported in metric tons. Barrels are calculated at the rate of 7.305 barrels per ton and rounded to three significant digits.

8/ Reported figure.

## TABLE 2
## GABON: STRUCTURE OF THE MINERAL INDUSTRY IN 1996

(Thousand metric tons unless otherwise specified)

| Commodity | | Major operating companies and major equity owners | Location of main facilities | Annual capacity |
|---|---|---|---|---|
| Cement: | | | | |
| Cement | | Société des Ciments du Gabon (Government, 91.4%; Elf Gabon, 8.6%) | Clinker-grinding plant at Owendo | 270 |
| Do. | | do. | Clinker-grinding plant at Franceville | 130 |
| Clinker | | do. | Clinker plant at N'Toum, 40 kilometers east of Libreville | 350 |
| Manganese, ore | | Compagnie Minière de l'Ogooué (Eramet, 46%; Government, 28%; Gengabon, 15%) | Open-pit mine at Moanda | 2,600 |
| Petroleum, crude | thousand 42-gallon barrels | Elf Gabon (Société Nationale Elf Aquitaine 75%; Government, 25%) | Anguille, Barbier, Baudroie, Bréme, Gonelle, Grondin Marine, Mandaros, and Torpille offshore fields | 30,000 |
| Do. | do. | do. | Avocette, Coucal, and Hylia fields | 25,000 |
| Do. | do. | Shell Gabon (Royal Dutch-Shell, 75%; Government, 25%), 42.5% interest in field | Rabi Kounga field, 100 kilometers north of Gamba | 75,000 |
| Do. | do. | do. | Gamba-Ivinga field, onshore Gamba | 4,000 |
| Do. | do. | Perenco Plc., 45% interest in field | Oguendjo offshore field, 85 kilometers southeast of Port Gentil | 3,000 |
| Do. | do. | Perenco Plc., 75% and Government, 25% joint venture | Lucina Marine offshore field, 15 kilometers south of Mayumba | 2,000 |
| Do. | do. | Perenco Plc., 50% and London and Scottish Marine, 50% joint venture | Obando, Octopus, and Pelican offshore fields, 60 kilometers southwest of Port Gentil | 5,000 |
| Petroleum products | do. | Société Gabonaise de Raffinage (Government, 25%; Elf Gabon, 18.7%; Total, 18.7%; Agip, 6.2%; BP, 6.2%; Fina, 6.2%; Mobil, 6.2%; Shell, 6.2%; and Texaco, 6.2%) | Refinery at Port Gentil | 8,760 |
| Uranium, oxide (metal content) | metric tons | Compagnie des Mines d'Uranium de Franceville (Compagnie Francais de Mokta, 39.2%; Compagnie Générale des Matières Nucléaires, 18.8%; Government, 24.7%; Minatom, 13%; and others, 4.3%) | Two mines near Mounana | 1,500 |

## THE MINERAL INDUSTRY OF

# GHANA

### By George J. Coakley

Ghana is a West African country with an area of 238,540 square kilometers, 17.5 million people, and a per-capita gross domestic product of about $1,400.[1] Its economic growth rate was 5%, led by gold, timber, and cocoa production. Ghana was the second-largest gold producer in Africa, after South Africa. It also was the third-largest African producer of aluminum metal and manganese ore and a significant producer of bauxite and diamond. Surpassing the historical role of cocoa as the leading export, gold has been Ghana's single most valuable export since 1992. In 1996, officially reported output of newly mined gold was 49 metric tons (t) with a market value of about $615 million.

## Government Policies and Programs

Restoration of the mining industry continued to be a keystone of the ongoing general Economic Recovery Program (ERP), launched in 1983 and structured in consultation with the World Bank. A significant early component of this program was the adoption of the mining code, the Minerals and Mining Law 1986 (PNDCL 153). In addition to this mining legislation, the ERP sought to improve the general economy through a combination of improved investment laws, a relaxation of foreign exchange restrictions, and the privatization of the large state-owned industrial sector, including several mines. By 1996, the Government had successfully privatised all the former holdings of the State Gold Mining Corp. (SGMC).

Legislation affecting mining and mineral exploration in Ghana includes the Additional Profits Tax Law, 1985 (PNDCL 122); the Minerals Commission Law, 1986 (PNDCL 154); and the Minerals (Royalties) Regulations, 1987 (LI 1349). The Petroleum (Exploration and Production) Law, 1984 (PNDCL 84), controls petroleum-related activities. Regulation of artisanal gold mining is set forth in the Small-Scale Gold Mining Law, 1989 (PNDCL 218). The Precious Minerals Marketing Corporation Law, 1989 (PNDCL 219), set up the Precious Minerals Marketing Corp. (PMMC) to promote the development of small-scale gold and diamond mining in Ghana and to purchase the output of such mining, either directly or through licensed buyers. The Minerals and Mining (Amendment) Act of 1994 reduced the 45% general mining corporate tax rate to 35%, the same as that imposed on other industries.

The Ministry of Lands and Natural Resources oversees all aspects of the Ghanaian mineral economy and is the grantor of mineral exploration and mining leases. Within the Ministry, the Minerals Commission has responsibility for recommending

mineral policy, promoting mineral development, advising the Government on mineral matters, and serving as a liaison between industry and the Government. The Ghana Geological Survey Department conducts geologic studies; the Lands Commission maintains records of exploration licenses and mining leases; and the Mines Department has authority in mine safety matters. All mine accidents and other safety problems also must be reported to the Ghana Chamber of Mines, the private association of operating mining companies. The Chamber also provides information on Ghana's mining laws to the public and negotiates with the mine labor unions on behalf of its member companies. The Ministry of Fuel and Power formulates Ghanaian energy policy and issues licenses for onshore and offshore petroleum and natural gas exploration.

Mining and the associated growth of communities has led to locally severe deforestation, erosion, and water pollution. Where sulfide gold ores have been roasted, there has been air pollution from sulfur and arsenic oxide emissions. Arsenic recovery circuits have been added to two of the three gold-processing plants in the country. Mercury is widely used to amalgamate gold by artisanal miners in Ghana. Artisanal usage in particular has led to mercury contamination of rivers. All new mining operations are required to conduct and submit environmental impact studies and to plan their operations to minimize environmental damage. Similarly, rehabilitation of existing mines now includes environmental planning. The Environmental Protection Agency was established in 1994, and draft guideline environmental regulations were issued. A portion of mining royalties are now directed to an environmental remediation fund, particularly to address problems in the artisanal sector.

## Production

As shown in table 1, production levels of Ghana's major mineral commodities were mixed in 1996. Aluminum, diamond, and manganese production levels increased 1%, 13%, and 450%, respectively, from those of 1995. The jump in manganese production was a result of the renovation of the Nsuta Mine under the management of Elkem International of Norway (Elkem). Output of bauxite declined by 10% and gold, by 8%. The decline in gold is not, however, reflective of the long term upward trend in gold production that is expected to continue as several new mines come into production in the next 1 to 3 years. Reported sales of artisanal gold production to the PMMC declined by 25% in 1996 over those of 1995. An unknown quantity of artisanal gold production is, however, undocumented owing to theft, internal consumption for jewelry and traditional gold ceremonial artifacts, or alleged smuggling into Cote d'Ivoire or Togo where the French West African franc is more convertible. Data were lacking for this commerce and estimates of its magnitude are not included in table 1. Power supply problems continued to beleaguer the Volta Aluminum Company Ltd.'s (VALCO) aluminum smelter, and metal production continued at about two-thirds of capacity in 1996. Cement was the main mineral commodity produced chiefly for local consumption.

---

[1] Where necessary, values for 1996 have been converted from Ghanaian cedis ₵ to U.S. dollars at the rate of ₵1,740=US$1.00.

## Trade

Virtually all Ghana's primary mineral production is exported, as is much of its secondary, or value-added, mineral output. In 1995, the value of all primary mineral commodity exports was $682 million, or about 45% of total exports. Gold exports, valued at $651.1 million, accounted for 95% of all mineral commodity exports in 1995. Available data for 1996 showed a similar pattern with gold, accounting for $612.4 million out of total exports of all goods of $1.51 billion. Because the true value of Ghana's diamond and gold exports was unknown owing to alleged smuggling, estimates of this commerce varied widely. A complicating factor was that the flow of diamonds and gold was informally reported in and out of the country. Ghana, in particular, appeared to be an entrepot for smuggled diamonds produced elsewhere in Africa; it would be a likely destination for artisanal diamond from Liberia and Sierra Leone, whose economies have been disrupted by civil wars in recent years. Although most official Ghanaian diamond exports were to Belgium and/or India, U.S. customs data have, in recent years, included imports of stones directly from Ghana in the range of 200,000 to 950,000 carats per year, worth $40 million to $126 million. The overall and average per-carat values of these stones are too high for the bulk of them to be Ghanaian production. Ghana's main processed mineral commodity export was aluminum, which is toll-refined in Ghana from imported alumina. On the basis of the average price of aluminum in 1996 of $0.70 per pound, aluminum exports were worth about $211 million, of which an estimated $73 million was the Ghanaian value-added component. Bauxite exports dropped 130,000 t to 400,000 t in 1996, due a train derailment that limited shipments.

Ghana's mineral commodity imports were dominated by petroleum products, alumina, fertilizers, and clinker for cement. Imports of these are estimated to have totaled about $350 million in 1994. Import data for 1995 and 1996 were not available, but are estimated to be at about the same level as those of 1994. Data on imports of mine and mill equipment, explosives, and reagents, such as sodium cyanide, were unavailable, but given the level of gold production and new mine developments, the value probably exceeds $200 million per year.

## Structure of the Mineral Industry

Through privatization programs, the Government has greatly reduced its once-dominant stake in the cement and gold industries but has maintained a controlling interest in Ghana Consolidated Diamonds Ltd., Ghana Bauxite Co. Ltd. (GBC), Ghana National Manganese Corporation (GNMC), and the state-run Steelworks Co. Negotiations to privatize some of these companies were underway. With the turnover of control of the Prestea Gold Mine to Barnato Exploration Ltd., an arm of the South African company, JCI Ltd., in 1996, the privatization of the assets of the SGMC was completed. Late in 1995, the Government signed an agreement with Elkem to assist the state-owned GNMC with operation of the Nsuta manganese mine. It was not clear, however, as to whether Elkem acquired an equity position under the agreement (Mining Journal, 1996). The Government had taken over control of the mine in 1973 from a subsidiary of Union Carbide of the United States.

Efforts to attract foreign investment in recent years have brought in a wide range of companies from Australia, Canada, the Netherlands, South Africa, the United Kingdom, and the United States that now hold controlling interests in most of the current gold mines in Ghana. In addition, more than 100 exploration licenses were being actively explored for gold during the year. The American company, Kaiser Aluminum Corp. (Kaiser), maintains a longstanding 90% interest in the VALCO aluminum smelter.

## Commodity Review

### *Metals*

**Aluminum and Bauxite.**—The VALCO smelter, Ghana's sole producer of aluminum, continued to be affected by drought-induced power disruptions and rationing and operated at only 68% of capacity. The smelter at Tema Harbor uses prebake technology and toll-processes alumina supplied by Kaiser and its minority shareholder, Reynolds Aluminum Co., into primary aluminum. Long-term tolling contracts provide for proportionate payments by the participants in amounts intended to pay not less than all VALCO's operating and financing costs. The company's share of the primary aluminum is sold to third parties. Power for the VALCO smelter is supplied under an agreement that expires in 2017. The agreement indexes two-thirds of the price of the contract quantity of power to the market price of primary aluminum. The agreement also provides for a review and adjustment of the base power rate and the price index every 5 years. The most recent review was completed in April 1994 for the 1994-98 period. The Volta River Authority has allocated to VALCO sufficient electric power to operate at 80% of its annual rated capacity through December 31, 1997 (Kaiser Aluminum Corp., 1997).

Ghana's only bauxite mine, operated by GBC at Awaso, produces chemical-grade bauxite ore primarily for export to Europe. Bauxite storage and shiploading facilities at Takoradi have been expanded in recent years and have contributed to a near doubling of mine production between 1993 and 1995, although production dropped by 10% in 1996. The company hopes to increase mine production to 1 million metric tons per year (Mt/yr) by 2000. The Government planned on selling

35% of its 55% holding in the mine by mid-1997. Alcan Chemicals Europe is the most likely company to buy the government shares and to increase its holdings in GBC to 80% (Mining Journal, 1997).

**Gold.**—Overall production of gold decreased by 8% from that of 1995, chiefly from drops in output from Ashanti Goldfields Company Ltd.'s (AGC) operations at Obuasi and at Teberebie Goldfields Ltd. (*See table 2.*) AGC emerged as a major force in African mining in 1996 by listing on the New York, Toronto, Zimbabwe, and Australian stock exchanges and by investing $518 million, or $38 per measured and indicated resource ounce acquired, to acquire four companies with significant gold properties in Ghana, Burkina Faso, Guinea, and Zimbabwe. The acquisitions included Cluff Resources plc. (United Kingdom), International Gold Resources Corp. (Canada), Ghana-Libyan Arab Mining Co. (Glamco) Ltd., Golden Shamrock Mines Ltd. (Australia), and the Republic of Ghana's minority interests in the Anyanfuri, Bibiani, and Iduapriem gold mines. AGC's corporate gold production for 1996 was 31,993 kilograms (kg), of which 93% came from operations in Ghana, including partial-year contributions from the Anyanfuri and Iduapriem Mines.

Of the 11 formal gold mines in operation in Ghana in 1996, 4 accounted for a total of 81% of the recorded gold output of the country. These four mines were: the Obuasi mine (54.2%), the Teberebie (13%), the Iduapriem (7.4%), and the Bogosu (6.7%). A breakdown of gold production, by mine, for 1992-1996 is shown in table 2.

One of the richest gold mines in the world, the Ashanti mining complex at Obuasi, experienced a drop in production of 8% in 1996 to 26,671 kg. The mine exploits quartz and sulfide ores from a steeply dipping vein and shear zone system in lower Proterozoic greenstones of the Birimian Series. Gold ore grades have averaged about 20 grams per metric ton (g/t) of gold for much of the mine's century-long history but have declined in recent years as the ratio of quartz to sulfide underground ore has decreased and as large quantities of lower grade surface ores and tailings have begun to be mined. Beginning in 1996 and adjusted for 1995, AGC began reporting on a calendar year basis ending December 31, a change from the old fiscal year ending September 30. The Obuasi underground mine delivered 1.78 million metric tons (Mt) of ore to the mill with an average grade of 8.13 g/t compared with 1.55 Mt of ore to the mill with an average grade of 8.66 g/t in calendar year 1995. At the Obuasi open-pit operations, 59.2 Mt of overburden was stripped, and 5.76 Mt of ore grading 3.1 g/t was mined in 1996 compared with ore production of 6.01 Mt grading 3.33 g/t in 1995. In 1996, AGC spent $161 million upgrading production facilities at Obuasi, primarily in underground shaft and ore haulage development. AGC has abandoned goals of producing 31,100 kilograms per year (kg/yr) of gold from Obuasi and will stabilize future production at a more optimum operating level of 26,440 kg/yr.

The Obuasi ore was processed at four treatment plants and a heap-leach operation. The Sansu sulfide treatment plant (STP) is the world's largest bio-oxidation (BIOX) gold treatment facility. BIOX is an environmentally benign, low-cost method of treating sulfide gold ores, especially those of too low a grade to justify the cost of roasting or other oxidizing processes. The process can handle arsenopyritic (high-arsenic) ores. The STP treated 2.67 Mt of ore grading 5 g/t in 1996 compared with 2.57 t grading 4.7 g/t gold in 1995. It had a gold recovery rate of 76.6% and contributed 10,234 kg, or 38% of total Obuasi gold production in 1996.

Ashanti's upgraded Pompora treatment plant processed 1.39 Mt of ore with an average grade of 8.02 g/t yielding 9,046 kg of gold. At the oxide treatment plant, 2.55 Mt of material were processed grading 2.72 g/t yielding 4,828 kg of gold with a recovery rate of 84.8%. The tailings treatment plant processed 1.8 Mt of ore grading 3.27 g/t yielding 2,119 kg of gold at a recovery rate of 36.1% in 1996. A small heap-leach plant processed 0.9 Mt of ore grading 0.93 g/t yielding 533 kg at a recovery rate of 62.1%.

At the end of 1996, Ashanti reported proven and probable reserves of 71.2 Mt at a grade of 7.9 g/t containing 560,000 kg of gold at Obuasi, 37.2 Mt grading 1.3 g/t at Iduapriem, 17.2 Mt at a grade of 2.7 g/t at Bibiani, and 3.1 Mt grading 1.3 g/t at Anyanfuri. In addition, Ashanti reported measured and indicated resources of 89.8 Mt at a grade of 7.5 g/t containing 672,000 kg of gold at Obuasi, 54.0 Mt grading 1.3 g/t at Iduapriem, 21.8 Mt at a grade of 2.6 g/t at Bibiani, and 3.1 Mt grading 1.6 g/t at Anyafuri (Ashanti Goldfields Co. Ltd., 1997).

During 1996, AGC merged with Golden Shamrock acquiring its 70% interest in Ghanaian Australian Goldfields, which operated the Iduapriem open pit gold mine. Total gold output for calendar 1996 decreased 5% from that of 1995 to 3,669 kg attributable to an expected drop in head grades. A new 2.4 Mt/yr heap leach project and carbon-in-leach (CIL) upgrade were commissioned in late 1996, increasing treatment capacity to 5 million metric tons per year (Mt/yr) and gold output to around 5,000 kg/yr.

During AGC's first year of ownership, the Ayanfuri Mine produced 1,717 kg of gold from heap-leaching operations, despite heavy rains during the middle of the year. About 300 kg of gold were produced by trucking higher grade Anyanfuri ore to Obuasi for treatment in the oxide plant CIL circuit. Exploration efforts outlined enough additional resources to extend the life of the mine 1 year beyond its early 1999 planned closure.

At its newly acquired Bibiani gold project, AGC completed additional drilling and a second and final feasibility study during 1996 and announced plans to proceed with development. The $83 million Bibiani project will be developed as an open-pit mining operation producing 2 Mt/yr of ore for treatment in a conventional crushing, milling, CIL circuit.

Teberebie Goldfields Ltd. (TGL), owned by the Pioneer Group, Inc., of the United States, operates the Teberebie Mine, near Tarkwa, and exploits the Tarkwaian System banket conglomerate, which is similar to the Witswatersrand gold environments of South Africa. The TGL open-pit, heap-leach operation, Ghana's second most productive gold mining company, extracts ore from the Teberebie/Awunaben and the Mantraim pits. Teberebie gold output decreased by 14% to 6,317 kg. The decline was attributed to dilution from heavy rains that reduced recovery from 78% to 69%. Ore processing also declined to 6.54 Mt grading 1.26 g/t in 1996 from the 7.07 Mt grading 1.28 g/t processed in 1995. In addition, operating costs were impacted by equipment downtime and a shortage of skilled labor. In March 1996, TGL received the necessary environmental permit from the Environmental Protection Agency to proceed with the Phase III expansion. The company was expending $57 million to expand ore processing capacity to 12 Mt/yr by adding a third gyratory crusher, by modifying the existing West plant, an absorption desorption refinery, and by adding a new South plant, which is expected to have its first gold pour by April 1998. TGL reported that a shift in mine method from selective mining to bulk mining might reduce existing proven and probable minable reserves of 283,000 kg of contained gold (Pioneer Group, 1997).

The Bogosu Mine, acquired by Gencor Ltd. of South Africa in 1994 through its purchase of Billiton International Metals B.V. of the Netherlands, is an open-pit operation exploiting very limited depleting oxide ores remaining from an earlier open-pit operation (the Marlu Mine). Billiton Bogosu Gold Ltd.'s processing facilities for sulfide ores, consisted of flotation, roaster, and CIL circuits. Production, primarily from oxide ores was 3,327 kg in 1996. Oxide reserves are sufficient for only one more year of production. In its 1996 Annual Report, however, Gencor stated that substantial, but metallurgically complex, sulfide ores exist on the property, which are technically amenable to mining and treatment by flotation, BIOX, and cyanidation. The remaining sulfide reserves were given as 11.76 Mt of indicated ore grading 3.32 g/t, and inferred reserves, as 813,000 t grading 2.7 g/t. (Gencor Ltd, 1996).

The Tarkwa Mine was the first active gold mine to be privatized in Ghana. Gold Fields of South Africa Ltd. (Gold Fields) acquired a 70% majority control in mid-1993 from the SGMC, with the Teck Corp. (Canada) subsidiary, Golden Knight Resources Inc., holding an additional 17.5%. Gold Fields (Ghana) Ltd. produced 1,476 kg of gold from the old underground workings in 1996. The parent companies announced the results of further exploration drilling in 1996 that increased the measured resource in the Tarkwa area from 233,000 kg of gold to 404,346 kg (Golden Knight Resources Inc., 1996; Gold Fields of South Africa Ltd., 1996). The ore is distributed in 324.2 Mt at an average grade of 1.37% gold in five areas in the southern end of the concession. After successful completion of a feasibility study Gold Fields, announced plans to undertake development of the $125 million Tarkwa open-pit, heap-leaching project. This first phase project will exploit 142 Mt grading 1.27 g/t gold at a 2.25 stripping ratio. Mining would be at the rate of 7.3 Mt/yr to produce 7,150 kg/yr of gold at full capacity. Initial startup capacity of 3,110 kg of gold is expected to be in operation by 1998. The project will involve the relocation of 20,000 Ghanaian villagers now resident above portions of the ore body. Additional exploration has identified nearby mineralization that may also be minable as a shallow underground mine (Randol International, 1996a).

On behalf of its subsidiary, Barnato Exploration Ltd. (Barnex), JCI Ltd. of South Africa signed an agreement with the SGMC to take over management control of the Prestea gold mine. Under its first year of operation by Barnex, production from the old Prestea underground workings increased by 26% to 1,062 kg of gold. The company reported that significant gold resources have been identified in the Prestea area during a reconnaissance drilling program and will be the target of further exploration in 1997 (JCI Ltd., 1996). Barnex was also actively exploring for gold elsewhere in Ghana on its own behalf and in joint ventures with the Canadian junior company, Patrician Gold Mines Ltd., and with a local company, Atlantis Mining Co.

Prestea Sankofa Gold Ltd., a joint venture of SAMAX Gold Inc. of the United Kingdom (50.4%), Ghana National Petroleum Co. (39.6%), and the Government (10%), was granted an 8-year lease in early 1994 to recover gold from the old Prestea Mine tailings and dumps. Prestea Sankofa commissioned a new 320,000-ton-per-year CIL plant in May 1995. This first phase investment cost $7.5 million and was designed to produce up to 680 kg/yr from an initial total of 1.8 Mt of old Prestea calcines, tailings, and mine waste for at least 7 years. Gold production in 1996 was 540 kg from 260,000 t of material remined grading 3.85 g/t. The gold recovery rate was 56.3%. SAMAX reported minable reserves of 1.84 Mt containing 3,575 kg of recoverable gold and further measured resources of 1.41 Mt containing 987 kg of recoverable gold (SAMAX Gold Inc., 1997).

Obenemasi Gold Mines Ltd, a subsidiary of Ghana Gold Mines Ltd. of Australia operated the historic Konongo/Obenemasi gold concession, located 50 kilometers (km) east of Kumasi. The company installed a 300,000-metric-ton-per-year mobile carbon-in-pulp plant in 1995 to treat the remaining oxide ores. Gold production in 1996 was 588 kg. A second phase will look at developing 1 Mt of proven minable sulfide ore reserves at a grade of 5.2 g/t below the Obenemasi open pits. Obenemasi is located within the Tarkwaian system banket conglomerate.

Bonte Gold Mines Ltd. (Bonte) increased output by 18%, to 668 kg of gold, from the small alluvial mining operation on the Esaase concession, which it is mining at a rate of 3,000 cubic meters per day. Bonte is owned (85%) by Akrokeri-Ashanti Gold Mines Inc. (Canada). Exploration on the company's adjacent Jena property outlined 2,940 kg of proven and probable reserves of contained gold and 2,700 kg of possible resources (Akrokeri-Ashanti Gold Mines Inc., 1997).

More than 100 companies, including a majority from Australia, Canada, Europe, Ghana, South Africa, and the United States, were actively exploring for gold in 1996. In addition to Ashanti's Bibiani project a number of advanced gold projects were underway.

Work was underway by Abosso Goldfields Ltd., a 90% owned subsidiary of the Australian company Ranger Minerals NL (Ranger), to open a mine on the Damang quartz vein stockwork deposit, an extension of the old Abosso underground mine adjacent to the Tarkwa Mine. The old Abosso Mine produced nearly 7,800 kg of gold before closing in 1956. As of October 1996, gold resources were estimated, allowing for dilution, at 94,244 kg of contained gold in 22.9 Mt of ore grading 3.1 g/t (Ranger Minerals NL, 1998). On the basis of a bankable feasibility study completed in February

1996, Ranger is proceeding with development of the new Damang Mine which it plans to have operational by the end of 1997. The $120 million project will mine at a rate of 3 Mt/yr and using a crushing, CIL process to produce from 8,400 to 9,000 kg/yr of gold (Randol International, 1996b).

During 1996, Resolute Samantha Limited of Australia merged with Associated Goldfields NL of Australia acquiring a 82.5% interest in the Obotan gold project; an additional 10% was held by the Ghana Government, and 7.5%, by Obotan Minerals Co. Ltd. The Obaton project, located 40 km northwest of Obuasi, includes the Nkran Hill and Adubiaso Hill surface deposits. Total resources are 21.9 Mt at a grade of 1.95 g/t of gold, including reserves of 10.15 Mt grading 2.12 g/t. A decision was made to proceed with development, with the first gold pour scheduled for June 1997. The $30 million project will include two open pits, a gold-treatment plant with a single stage crushing circuit and semiautogenous grinding mill, seven CIL tanks, and a 5-t gold circuit. The deeply weathered ore is free milling with gold recoveries expected in excess of 93%. Mining and plant throughput will be at a rate of from 1.4 to 2 Mt/yr of ore based on mining reserves of 28,000 kg of gold. Annual production is planned to be 126,000 kg of gold. (Resolute Limited, 1997).

Glencar Explorations Plc. of Ireland, which owned 63% of Wassa Holdings Limited, reported promising exploration results from drilling at the Wassa project in its 1996 annual report. Wassa Holdings Limited holds 90% of the Ghana registered operating company, Satellite Goldfields Ltd., with the Government of Ghana holding the remaining 10%. The Wassa property is located about 35 km northeast of Tarkwa in Lower Birimmian greenstones, felsic volcanics and a distinctive ironstone formation. Vein and stockwork mineralization occurs in both the felsic and phylittic lithologies. Minable reserves were estimated to be 14.7 Mt at a grade of 1.8 g/t of gold. In August 1996, the total probable minable reserve on the property was estimated to be 26,440 kg at a cut-off grade of 0.8 g/t; the ore body is still open on several sides. The American engineering firm, Pincock, Allen, & Holt, is expected to complete the feasibility study on the project by mid-1997. The study is based on producing 3,420 kg/yr of gold for 7 years from an open-pit, heap-leaching operation. Glencar also held exploration rights to the Kanyankaw property, on which drilling was being conducted by Cyprus Amax Minerals Co. of the United States under an Earn-In Agreement (Glencar Explorations Plc., 1997).

Gencor also reported that initial geologic drilling at the Yamfo project in northern Ghana resulted in resource estimates of 40,000 kg of gold, which would be exploited as an open pit (Gencor Ltd., 1996).

**Manganese.**—Ghana Manganese Corporation's Nsuta Mine has been the only significant producer of manganese ore in Ghana. The mine produces manganese oxide and carbonate ores, as well as a transitional ore referred to as "Carbox." Total production of manganese ore in 1996 was 789,449 t of run-of-mine ore equivalent to 411,000 t of contained manganese. Except for a few hundred tons of battery-grade oxide ore sold to local battery companies and very small amounts sold to gold-processing plants, the mine's ore sales were exports. Exports of manganese were reported to be 266,440 t, in 1996. The Nsuta Mine's total production and export capacities have been constrained by limited rail capacity to Takoradi Harbor. The railroad is also shared with the Awaso bauxite mine.

### *Industrial Minerals*

**Diamond.**—Ghana Consolidated Diamonds' Akwatia diamond mine was the only operating mine in Ghana in 1996. The Ghana Minerals Commission reported output at 271,494 carats, down by 8% from 1995. Apart from Akwatia, diamond production in Ghana during the year was from widespread artisanal workings. The true level of artisanal output was unknown because of undocumented sales and exports. In 1996, the PMMC reported purchases of 443,243 carats from artisanal and galamsey miners, an increase of 31% from those of 1995.

Several Canadian companies continued with diamond exploration in the general Akwatia area. Most work targeted placer deposits, but one company was also evaluating newly discovered metakimberlites on its concession.

**Limestone.**—Limestone Products (Ghana) Ltd. was formed in 1994 to supply limestone and lime to the gold mining industry and for water treatment. The company's limestone-crushing and lime-processing facilities, near Takoradi, also provide storage for imported lime and limestone. The company was examining local deposits of sea shells along with a nearby limestone deposit as feed sources. The prime customer for the company was its joint venture owner, AGC, which required quicklime, hydrated lime, limestone, and shells for its BIOX gold recovery circuit. In 1995, AGC reduced its participation from 51% to 50% with the remaining 50% held by Carmeuse S.A. of Belgium. Carmeuse, one of the world's leading companies in the lime products industry, was also planning to pursue other domestic and regional markets.

### Reserves

GBC claimed that it had access to bauxite reserves at Awaso sufficient to support a mine life of 100 years, while reporting proven reserves at the end of 1994 of 29.5 Mt (Ghana Chamber of Mines, 1994). Mining plans in 1994 called for output to be expanded to 500,000 metric tons per year (t/yr) and eventually to be doubled to 1 Mt/yr. As reported by the former director of the Geological Survey Department, the country has significant bauxite reserves outside the Awaso area, namely about 60 km west of Kumasi, and those near Kibi. These have been extensively drill sampled. The deposits near Kumasi have an inventory totaling 278 Mt at a grade range of 48.9% to 51% alumina and 2.8% to 4.4% silica. The Kibi area bauxite resource totals 120 Mt ranging in grade from 40.8% to 45.7% alumina and 1.8% to 3.9% silica (Kesse, 1985).

Ghana has large gold resources, although summation of them is complicated by the different reserve reporting methods used by various companies. Published data from the existing mines and for certain advanced projects indicate a total defined Ghanaian resource for year-end 1995 in the range of 1,300 to 1,500 t of contained gold; the Obuasi Mine had about 45% of this inventory. Available information on reserves and resources of gold at individual mines are discussed in the gold commodity section of this report. Ghana's total gold resources, which are undoubtedly larger than those reported, are based on the known extent of host rocks, the widespread artisanal production of gold, and the existence of a number of closed old mines, many of which shut down without having depleted their gold resources and which are just beginning to be reevaluated using current geologic models and considering current processing technology.

The only large established manganese ore reserves in Ghana are at the Nsuta Mine, although several other deposits are known. As of the end of 1994, minable reserves were 222,600 t of manganese oxide and 4,326,300 t of manganese carbonate ore (Ghana Chamber of Mines, 1994).

Ghana's large diamond resources are based on reserves at the Akwatia Mine and the widespread artisanal production of diamond. The Akwatia Mine's reserves are virtually all in river or raised terrace gravels along the Birim River. According to the company, proven reserves in these gravels amounted to about 19.7 million cubic meters grading about 1.19 carats per cubic meter (Ghana Chamber of Mines, 1994). Unlike the richer diamond fields in Sierra Leone and Guinea, very few large, gem-quality stones are found at Akwatia. The departure of two potential major international mining company investors, including De Beers Consolidated Mines Ltd. (South Africa), in the early 1990's from Akwatia, however, puts the economics of the deposits in question. Kimberlites now have been found in the area, but the diamond resources are still being evaluated.

Recent exploration has been able to define Ghana's oil and gas resources better. In the petroleum sector 1 onshore and 5 offshore basins with commercially viable oilfields have been discovered but are still awaiting development. Natural gas reserves have been estimated at 24 billion cubic meters, chiefly in the Tano offshore gasfield (Mbendi Information Services, 1996). With a $316 million financing support from the U.S. Eximbank plans are underway to develop the Tano gasfield and to build pipelines to a barge mounted 130,000-kilowatt powerplant to be installed near the village of Effasu (Oil & Gas Journal, 1996).

## Infrastructure

Ghana's road infrastructure is concentrated in the southern and southwestern parts of the country. Apart from some of the roads between the main cities, much of the country's road network remained in poor condition, unsuitable for transport of bulk mineral commodities. Ghana's railroad infrastructure remained in poor condition except for rehabilitated sections of the western line. This line is the export route for the country's manganese ore and bauxite and provides logistical support to the major gold-producing area.

Ghana's major ports are Takoradi and Tema. All the country's manganese ore and bauxite shipments are through Takoradi. Tema, a shallow, dredged harbor, handles the needs of the VALCO aluminum smelter. Both ports handle imports of clinker for cement. In 1996, the Government announced plans to invest $240 million to renovate both ports as part of a policy to promote Ghana as a gateway to the West African region.

Ghana's electrical generating capacity remained at about 1,185 megawatts (MW), of which 1,072 MW was from hydropower. Hydroelectric power is subject to the impact of periodic droughts in the region, and power disruptions and rationing were common. Electricity exports from the Volta River Authority to neighboring countries were terminated in 1994.

## Outlook

Fostered by a favorable political and investment climate, the prospects for continued development of the mining sector of the Ghanaian economy looked promising. Gold should continue to lead growth in the minerals sector and in the overall economy, having overtaken cocoa as the leading export. The aggressive expansion of operations by Ashanti, the post privatization revitalization of the SGMC holdings and the potential for ongoing exploration to add one to three new mines per year should see annual gold production approach 2 million ounces (62,200 kg) in the near future. The introduction of internationally accepted environmental standards by the Government may, however, slow the rate of exploration and development. Owing to periodic droughts, domestic energy supply, especially hydroelectric power, has been a problem, particularly for the aluminum industry and the expanding needs of the gold industry. The proposed new gas fueled power plant at Effasu should help mitigate this problem.

## References Cited

Akrokeri-Ashanti Gold Mines Inc., 1997, Akrokeri-Ashanti announces exploration program and revised reserve figure: Akrokeri-Ashanti Gold Mines Inc. press release, January 31, 2 p.

Ashanti Goldfields Co. Ltd., 1997, Annual Ashanti Goldfields report, 1996: Ashanti Goldfields Co. Ltd, March, 69 p.

Gencor Ltd., 1996, Annual Gencor report for fiscal year ending June 30, 1996: Gencor Ltd., p.50-51.

Ghana Chamber of Mines, 1994, Annual Chamber of Mines report, 1994: Ghana Chamber of Mines, p. 44-45.

Glencar Explorations Plc., 1997, Annual Glencar report, 1996: Glencar Explorations Plc, 30 p.

Golden Knight Resources Inc., 1996, Golden Knight—First phase of large gold mine at Tarkwa viable: Golden Knight Resources Inc. press release, August 23, 2 p.

Gold Fields of South Africa Ltd., 1996, Annual Gold Fields report, 1996: Goldfields of South Africa Ltd., p. 17.

Kaiser Aluminum Corp., 1997, Form 10-K—1996: U.S. Securities and Exchange Commission, p. 11. (Accessed on the World Wide Web at URL http://www.sec.gov/Archives/edgar/data/54291/0000054291-97-000026.txt)

JCI Ltd., 1996,. Annual JCI report for fiscal year ending June 30, 1996: JCI Ltd., p. 24.

Kesse, G.O., 1985, The mineral and rock resources of Ghana: Rotterdam, A.A. Balkema, p 95-156.

Mbendi Information Services, 1996, Ghana—Oil industry profile: Mbendi Information Services, (South Africa), 3 p. (Accessed August 14, 1996, on the World Wide Web at URL http://mbendi.co.za/cyghoi.htm.)

Mining Journal, 1996, Ghana: in Mining Annual Review—1996, Mining Journal (London), July, p. 160-163.

———1997, Ghana's bauxite exports fall: Mining Journal (London), January 10, v. 328, no. 8411, p. 22.

Oil & Gas Journal, 1996, Project off Ghana gets support from U.S. Exim bank: Oil & Gas Journal, v. 94, no. 15, April 15, p. 29.
Pioneer Group, Inc., 1997, Form 10-K—1996: U.S. Securities and Exchange Commission, p. 10-14.
Randol International, 1996a, Ghana's Ashanti gold belt—New horizons: Randol International Mining Opportunities Bulletin, v. 3, no. 2, summer, p. 15.
———1996b, Ranger Minerals's Damang gold deposit: Randol International Mining Opportunities Bulletin, v. 3, no. 2, summer, p. 16.
Ranger Minerals NL, 1998, Operations: Ranger Minerals NL, 1. p. (Accessed February 3, 1998, on the World Wide Web at URL http://www.ranger.com.au/operations.htm.)
Resolute Limited, 1997, Annual Resolute Limited report, 1996. (Accessed February 3, 1998, on the World Wide Web at URL http://resolute-ltd.com.au/.)
SAMAX Gold Inc, 1997, Prestea Sankofa Gold Limited-Ghana: SAMAX Gold Inc. undated company release presented at African Mining Investment onference, Cape Town, South Africa, February 4-7, 1 p.

## Other Sources of Information

Geological Survey Department
P.O. Box M 80
Accra, Ghana
Telephone: 233-21-228093
Minerals Commission
P.O. Box M 248
Accra, Ghana
Telephone: 233-21-772-783/772-786
Fax: 233-21-773-324
Mines Department
P.O. Box 3634
Accra, Ghana
Telephone: 233-21-77536/776802
Fax: 233-31-24344 (Takoradi office)
Ghana Chamber of Mines
P.O. Box 991
Accra, Ghana
Telephone: 233-12-665-355/665-356
Fax: 233-12-662-926

## Internet References

Republic of Ghana Home Page
http://www.ghana.com/republic/
Mbendi Information Services, Ghana Profile
http://mbendi.co.za/cyghcy.htm
Ashanti Goldfields Press Releases - through Canadian Corporate News Online
http://www.cdn-news.com/

## TABLE 1
## GHANA: PRODUCTION OF MINERAL COMMODITIES 1/
(Thousand metric tons unless otherwise specified)

| Commodity 2/ | | 1992 | 1993 | 1994 | 1995 | 1996 e/ |
|---|---|---|---|---|---|---|
| Aluminum: | | | | | | |
| Bauxite, gross weight | | 399 | 365 | 452 | 697 | 631 3/ |
| Metal, smelter, primary | | 180 | 175 | 141 | 135 | 137 3/ |
| Arsenic, trioxide 4/ | metric tons | 500 r/ e/ | 902 r/ | 3,897 r/ | 4,409 r/ | 5,443 3/ |
| Cement, hydraulic 5/ | | 1,020 | 1,200 | 1,350 | 1,300 e/ | 1,300 |
| Diamond: | | | | | | |
| Gem e/ | thousand carats | 525 | 473 | 592 | 506 | 572 |
| Industrial e/ | do. | 131 | 118 | 148 | 126 | 143 |
| Total 6/ | do. | 656 | 591 | 740 | 632 | 715 3/ |
| Gold 7/ | kilograms | 29,824 r/ | 38,911 r/ | 43,478 r/ | 53,087 r/ | 49,211 3/ |
| Manganese: | | | | | | |
| Ore, processed | | 353 | 295 e/ | 265 | 217 | 789 3/ |
| Mn content e/ | | 133 | 115 | 101 | 91 | 411 |
| Petroleum, refinery products: | | | | | | |
| Liquefied petroleum gas | thousand 42-gallon barrels | 197 | 40 | 365 | 400 e/ | 400 |
| Gasoline | do. | 1,800 | 325 | 1,825 | 1,900 e/ | 1,900 |
| Jet fuel | do. | 384 | 100 | 365 | 400 e/ | 400 |
| Kerosene | do. | 798 | 200 | 1,095 | 2,000 e/ | 2,000 |
| Distillate fuel oil | do. | 1,580 | 400 e/ | 1,460 | 1,500 e/ | 1,500 |
| Residual fuel oil | do. | 1,900 | 475 | 2,190 | 2,200 e/ | 2,200 |
| Other including refinery fuel and losses e/ | do. | 801 | 210 | 365 | 400 | 400 |
| Total | do. | 7,460 e/ | 1,750 8/ | 7,665 | 8,800 e/ | 8,800 |
| Salt e/ | | 50 | 50 | 50 | 50 | 50 |
| Silver, content of gold ore e/ | kilograms | 1,550 | 1,960 | 2,230 | 2,660 | 2,450 |
| Steel, crude e/ | | 25 | 25 | 25 | 25 | 25 |

e/ Estimated. r/ Revised.

1/ Table includes data available through Mar. 13, 1998.

2/ In addition to the commodities listed, a variety of crude construction materials (clays, sand and gravel, and stone) are produced, as is limestone for processing of some gold ore. Output of these commodities is not reported and information is inadequate to make reliable estimates of output levels.

3/ Reported figure.

4/ Reported data from AGC. Bogosu roaster may also produce arsenic.

5/ All from imported clinker.

6/ Production, in thousand carats, includes that of Akwatia Mine (1992--214; 1993--214; 1994--356; 1995--294; and 1996--271), and PMMC purchases of artisanal production (1992--480; 1993--376; 1994--406; 1995--337; and 1996--443). Estimates of unreported artisanal production not included.

7/ Does not include estimate of smuggled production.

8/ Refinery was reported closed for maintenance for much of the year.

## TABLE 2
## GHANA: GOLD PRODUCTION BY COMPANY AND MINE
(Kilograms)

| Company | Mine | 1992 | 1993 | 1994 | 1995 | 1996 |
|---|---|---|---|---|---|---|
| Ashanti Goldfields Co. Ltd. | Ayanfuri, open pit 1/ | -- | -- | 139 | 1,744 | 1,717 |
| Do. | Iduapriem, open pit 2/ | -- | 3,835 | 3,689 | 3,866 | 3,669 |
| Do. | Obuasi Complex, open pit and underground | 21,390 | 23,831 r/ | 26,548 | 29,138 | 26,761 |
| Barnex (Prestea) Ltd. | Prestea, underground 3/ | 525 | 654 | 612 | 840 | 1,062 |
| Billiton Bogosu Gold Ltd. | Bogosu, open pit | 2,428 | 2,784 | 3,402 | 3,349 | 3,327 |
| Bonte Gold Mines Ltd. | Esaase, placer | -- | 227 | 508 | 567 | 668 |
| Dunkwa Continental Goldfields Ltd. | Dunkwa, placer 4/ | 145 | 122 | 97 | 104 | 173 |
| Gold Fields (Ghana) Ltd. | Tarkwa, underground 5/ | 827 | 1,221 r/ | 1,224 | 1,382 | 1,476 |
| Obenemasi Gold Mines Ltd. | Konongo/Obenemasi, open pit 6/ | 46 | -- | -- | 690 | 588 |
| Precious Minerals Marketing Corp. | Artisanal workings 7/ | 538 | 1,107 r/ | 1,772 | 3,898 | 2,913 |
| Prestea Sankofa Gold Ltd. | Prestea, tailings 8/ | -- | -- | -- | 184 | 540 |
| Teberebie Goldfields Ltd. | Teberebie, open pit | 3,925 r/ | 5,129 | 5,487 r/ | 7,325 | 6,317 |
| Total | | 29,824 r/ | 38,911 r/ | 43,478 r/ | 53,087 r/ | 49,211 |

r/ Revised.

1/ Acquired in purchase of Cluff Resources in 1996.

2/ Acquired in merger with Golden Shamrock in 1996.

3/ Acquired from SGMC in 1996.

4/ Acquired from SGMC in 1995.

5/ Acquired from SGMC in 1993.

6/ Owned/operated by Southern Cross Mining Co. in 1991-92.

7/ Includes 8 to 110 kilograms per year byproduct gold from Ghana Consolidated Diamonds Ltd.'s Akwatia Mine.

8/ Acquired from SGMC in 1994.

Source: Ghana Minerals Commission

### THE MINERAL INDUSTRY OF

# GUINEA

### By Philip M. Mobbs

Guinea was the world's second largest bauxite producer and held the world's largest bauxite reserves. The aluminum industry continued to dominate Guinea's mineral economy. The limited domestic demand for crude minerals (less than 10% of produced bauxite was used to produce alumina in Guinea) resulted in the mineral sector effectively dominating the nation's exports.

Mineral production and processing accounted for about 25% of the nation's gross domestic product. Mineral exports, primarily alumina, bauxite, diamond, and gold, accounted for approximately 90% of the country's total exports. Guinea supplied 33% of the United States' total bauxite imports in 1996. The mining industry consumed approximately 55% of the country's petroleum products imports.

Subsequent to the short-lived February 1996 army rebellion, the Government cited a "fragile state of public finances, governmental inefficiency, weak private investment, and continued high unemployment" as reasons for the national condition (U.S. Embassy, Conakry, Guinea, 1996). To assuage the situation, the Government encouraged infrastructure development, promoted mineral industry expansion, and made the improvement of the investment climate a priority. Among the announced economic reforms was a 50% increase in the mining industry's preferential fuel rates. The rate increase effectively raised the industry's mining, transportation, and remote site electrical power generating costs.

The new Guinean mining code of 1995 defined incentives, mineral ownership, mining fees, mining titles, royalties, and other taxes. The Government reserved 15% free equity in gold and gem operations for itself. The state's participation in bauxite- and iron-mining ventures was subject to negotiation. Mineral beneficiation in Guinea was encouraged. Under the new law, the royalty on alumina was 5% and 3.5% on concentrates compared with 10% for bauxite and 7% for other ores. The corporate income tax rate was 35%.

In addition to possessing significant bauxite reserves, the nation had diamond, gold, granite, and iron deposits. The Government was encouraging the expansion of the bauxite sector and promoting the diversification of the mineral industry. The Government also indicated that chromium, cobalt, graphite, limestone, manganese, nickel, tin, and uranium resources existed in the country, but need additional investigation (Ministère des Mines et de la Géologie, 1995).

Commercial production of bauxite, diamond, and gold was significantly augmented by artisanal production of diamond and gold in 1996. *(See table 1.)* The production of bauxite was dominated by three companies.The Compagnie des Bauxites de Guinée (CBG) operated a number of open pit bauxite mines in the Boké District. During 1996, CBG had rapidly expanded its production capacity to almost 14 million metric tons per year (Mt/yr). The Société des Bauxites de Kindia (SBK) was restoring production to the operation's nominal 3-Mt/yr capacity. SBK's production was exported to the Ukraine. The Société d'Economie Mixte Friguia planned to double its alumina plant capacity. Additionally, the Government was encouraging development of the proposed 600,000-metric-ton-per-year Dabola and the 11-Mt/yr Dian-Dian bauxite operations.

Artisanal operators have mined gold placers for many years in the Kankan, Kouruossa, Mandiana, and Siguiri regions, known as "la zone du Boure." Artisanal diamond and gold miners continued to operate alongside foreign company exploration activities, despite the efforts of the concession holders.

The Société Minière de Dinguiraye (SMD), operated a mine at Léro in northern Guinea. SMD was owned by the Government (15%) and Delta Gold Mining (85%), a Jersey registered corporation of the United Kingdom. Delta, in turn, was owned by Kenor A.S. of Norway, and by Mine Or, the gold operations subsidiary of La Source Group of France. Razel, a French construction company, had the contract to operate the open pit mine. Unweathered dolerite contamination in the ore adversely affected crusher operations and abundant clay-sized material in the lateritic ore continued to cause agglomeration problems. SMD planned to install a new primary crusher in 1997.

Gold was first poured at Léro in April 1995. During 1996, 547,000 metric tons (t) of ore was mined; 337,000 t agglomerated, stacked and leached; and 210,000 t of ore was stockpiled. SMD produced 1,207 kilograms of gold from Léro during 1996.

SMD also continued to explore the Dinguiraye concession, which included the region surrounding the Léro Mine and the Fayalala prospect, as well as the Bofeko, Matagania, and North Matagania placer deposits. Kenor announced reserves at Léro of 704,000 t grading 3.4 grams of gold per ton (Kenor A.S., 1996). Kenor also completed the Fayalala feasibility study during 1996. The study indicated that the Fayalala oxides were amenable to dump leaching, eliminating the costs of agglomeration (Kenor A.S., 1997).

The diamond region in the southeast and the gold region in the northeastern sector of Guinea, near the Mali border, were the sites of an international exploration frenzy. A number of companies held diamond or gold exploration permits. However, most exploration activity was in the preliminary stages.

Golden Shamrock Mines Ltd. (GSM) of Australia accepted the feasibility study on the Siguiri gold project and recommended that the Société Aurifère de Guinée (SAG) proceed with the venture. At mid-year, Ashanti Goldfields Co. Ltd. of Ghana acquired GSM and its 70% interest in SAG. The joint venture of Ashanti and AGEM Ltd., a subsidiary of IAMGOLD Ltd. of Canada, were drilling on the Mandiana exploration permit in northeastern Guinea. Les Minéraux SGV SA, the 50-50 joint venture between West Africa Mining Exploration Corp. Inc. (SEMAFO) and Emerging Africa Gold (EAG) Inc., an affiliated company of St. Geneviève Resources Ltd. of Canada, was drilling and trenching the Jean and the Gobéle vein systems on its concession.

Other companies active in Guinea included Cambrian Resources of Australia, prospecting on the Kouroussa concession; the First Quantum Minerals Ltd. of Canada and Reunion Mining plc of the United Kingdom joint venture on the Nyantanina exploration permit; Kenor's subsidiary, Goldex AS, on the Bananfara Permit; and Les Minéraux, on the Sumandou permit. Lithos Corp. of Canada acquired interest in the Apredor ground reconnaissance permit during 1996. Also involved in Guinea were the joint venture of SAGEM S.A. of Guinea and New Sage Resources, the Canadian subsidiary of Striker Resources NL of Australia, on the Sankarani gold deposit; and Wells Gold Corp. NL of Australia on the Kossaken concession. Additionally, African Selection Mining Corp. of Canada, Bassad Guinea S.A. of Guinea, Cyprus-Amax Minerals Co. of the United States, International Mining Co. S.A. of Guinea, and Golden Limbo Rock Ressources S.A., a subsidiary of Mano River Resources Ltd. of Switzerland held interest in exploration permits in Guinea, as well as Jade Mining Corp., Northern Abitibi Mining Corp. of Canada, Pacific Galleon Mining Corp. of Canada, the joint venture between Patrician Gold Mines Ltd. of Canada and Chalice Mining Inc. of Canada, and the joint venture of Rodera Diamond Corp. of Canada and Samran Metals and Mining of the United Kingdom.

The kimberlite pipes near Banankoro were believed to be the source of Guinea's unusually large, high-quality diamond gemstones. Nationwide, 70% to 80% of diamond production was of gem quality. Diamonds were recovered from alluvial gravels in the valleys of the Baoule and Bimboko Rivers and their tributaries. This area contained about two-thirds of the country's known diamond placer reserves and accounted for approximately 80% of the official production of diamonds.

The Association pour la Recherche l'Exploitation du Diamants et de l'Or (Aredor) diamond mine in Gbenko was closed in 1994 and relinquished by Bridge Oil Co. of Australia because of spiralling operating costs and the continued presence of artisanal miners on the company's concession. During 1996, First City Mining Co. Ltd. of Canada and Consolidated African Mines Ltd. of South Africa acquired the Aredor Concession that included the former Aredor Mine. Their operating company, Aredor FCMC S.A., began pilot-plant operations in May and recovered 3,828 carats of diamond by yearend (Trivalence Mining Corporation, 1997). Trivalence Mining Corp. of Canada subsequently acquired First City and its interest in Aredor during 1996.

Hymex Diamond Corp., of Canada's subsidiary Hymex Guinea S.A., installed a new wash plant and recovered 21,552 carats of diamond during 1996.

Total bauxite reserves were estimated at about 20 billion metric tons grading more than 40% aluminum oxide according to the Ministry of Natural Resources and Energy. Iron resources were estimated to be about 6 billion metric tons grading 64% to 68% iron. Gold reserves were estimated between 200 and 1,000 t, and the Government also estimated there were reserves of 20 million carats of diamond in Guinea, with 70% to 80% gem quality (Ministère des Ressources Naturelles et de l'Energie, 1997).

Mining railroads totaled 239 kilometers (km) of standard-gauge line and 806 km of 1-meter (m) line. A 135-km standard-gauge line linked the Sangarédi Mine with the Port of Kamsar, and a 104-km standard-gauge line linked the Kindia Mine with Conakry. A 145-km, 1-m line linked the Fria Mine with Conakry. In addition to the mine railroads, 661 km of 1-m-gauge line connected Conakry with Kankan; this line was undergoing rehabilitation. The Dabola-Conakry segment of the Conakry-Kankan line needed to be upgraded to support the Dabola project.

Guinea had two main ports: Kamsar and Conakry. Kamsar served the Sangarédi Mine, handling only bauxite shipments. Conakry served the Fria and Kindia Mines and also was the country's main general cargo port. The country had 1,280 km of navigable waterways.

Caisse Française de Developpment of France was funding the 75-megawatt (MW) capacity Garafiri hydroelectric project on the Konkoure River and a 11.75-MW expansion of the capacity at Tombo thermal power station in Conakry. Electricity production from Garafiri was anticipated by 1999.

The 1995 mining code significantly improved the business climate for the mineral industry. However, mineral operations remained hampered by infrastructural constraints. Guinea's transportation network was improving slowly. International development of mineral deposits was proceeding more slowly than anticipated. The less-than-expected foreign investment was attributed to the country's perceived political and economic risks, as well as civil disturbances in adjacent Liberia and Sierra Leone.

Bauxite and alumina are expected to continue dominating Guinea's economy. The addition of the CBG's Bidikoum Mine should help maintain the high quality of the nation's bauxite exports. Alumina production capacity was expected to increase given the proposed renovations, capacity expansions, and new projects. Ventures requiring significant electric power availability, such as an aluminum smelter, could become feasible as the nation's power generation capacity is increased as planned.

Guinea's formal diamond and gold industries could thrive if new investments and exploration programs expanded production and attracted additional international interest. The activation of the Léro gold mine and the proposed production from the Fayalala, Mandiana, and Siguiri gold deposits should provide some industry diversification in addition to extra revenue for the Government. The proposed 6-Mt/yr Nimba iron ore mining project remains dependent upon resolution of Liberia's civil war and access to an export route through Liberia.

## References Cited

Kenor A.S., 1996, Kenor annonser økning i reserver i Léro gruver: Kenor A.S. press release, November 13, 1996. (Accessed November 19, 1996, on the World Wide Web at URL http://hugin.sn.no/Ken/PM/9611113141815.html)

———1997, Annual report—1996: Kenor A.S., unpaginated, Oslo. (Accessed August 20, 1997, on the World Wide Web at URL http://hugin.sn.no/ Ken /AR/ken96_e.pdf)

Ministère des Mines et de la Géologie, 1995, Symposium sur les investissements dans le Secteur Minière en Afrique: Ministère des Mines et de la Géologie, 8 p.

Ministère des Ressources Naturelles et de l'Energie, 1997, Symposium sur les investissements dans le Secteur Minière en Afrique: Ministère des Ressources Naturelles et de l'Energie, 7 p.

Trivalence Mining Corporation, 1997, May diamond production increases by 93% to 3133 carats: Trivalence Mining Corp. news release, June 4, 1997. (Accessed August 19, 1997, on the World Wide Web at URL http://www.trivalence.com/news/jun4-97.html)

U.S. Embassy, Conakry, Guinea, 1996, New Guinean Prime Minister vows "My mission will be essentially economic": U.S. State Department Telegram Conakry 3645 (July 18, 1996), 3 p.

## Major Source of Information

Ministère des Ressources Naturelles et de l'Energie
Centre de Promotion et du Development Minier
P.O. Box 295
Conakry, Republic of Guinea
Telephone: (224) 41-51-44
Fax: (224) 41-49-13

## Major Publications

Morgan, George A., Izon, David, and Sow, Nene Ousmane, 1992, Mineral economy of Guinea: U.S. Bureau of Mines Mineral Perspectives, 24 p.

Rombouts, Luc, 1987, Evaluation of low grade/high value diamond deposits: Mining Magazine, v. 157, no. 3, September 1987, p. 217-220.

### TABLE 1
### GUINEA: PRODUCTION OF MINERAL COMMODITIES 1/

(Thousand metric tons unless otherwise specified)

| Commodity | | 1992 | 1993 | 1994 | 1995 | 1996 |
|---|---|---|---|---|---|---|
| Alumina: | | | | | | |
| Production: | | | | | | |
| Hydrate | | 601 | 642 | 648 | 630 r/ | 650 |
| Calcined | | 561 | 656 | 640 | 616 r/ | 640 |
| Shipments, calcined | | 553 | 656 | 545 | 616 r/ | 619 |
| Bauxite: | | | | | | |
| Mine production: | | | | | | |
| Wet basis 2/ | | 16,100 r/ | 17,100 r/ | 14,900 r/ | 18,000 r/ | 18,700 |
| Dry basis 3/ | | 14,300 r/ | 15,300 r/ | 13,300 r/ | 15,800 r/ | 16,500 |
| Calcined | | 96 | 80 r/ | 89 | 244 r/ | 95 |
| Shipments (dry basis): | | | | | | |
| Metallurgical | | 12,314 | 13,617 | 11,033 | 12,304 | 12,304 |
| Calcined | | 95 | 79 r/ | 91 | 89 | 95 |
| Diamond 4/ 5/ | thousand carats | 153 r/ | 167 r/ | 381 r/ | 365 | 205 |
| Gold 5/ | kilograms | 5,140 r/ | 3,864 r/ | 5,617 | 7,863 r/ | 6,838 |

r/ Revised.

1/ In addition to the commodities listed, modest quantities of crude construction materials (clays, sand and gravel, and stone) presumably are produced but output is not reported quantitatively, and available information is inadequate to make reliable estimates of output levels. Table includes data available through Aug. 27, 1997.

2/ Metallurgical plus calcinable ore estimated at 13% water.

3/ Data are for wet-basis ore estimated at 13% water, reduced to dry basis estimated at 3% water.

4/ Production is approximately 70% to 80% gem quality.

5/ Figures include artisanal production.

## THE MINERAL INDUSTRY OF

# KENYA

### By Philip M. Mobbs

Soda ash was the most important mineral commodity produced in Kenya in 1996. Other mineral commodities produced included cement, fluorspar, gemstones, gold, petroleum products, and salt. The mineral industry accounted for about 1% of the country's gross domestic product (Ministry of Environment and Natural Resources, 1997).

Kenya's major trading partners in Africa and the European Union received about 80% of the nation's exports. Agricultural products dominated the export markets, but fluorspar, petroleum products, and soda ash were notable sources of foreign exchange earnings. Petroleum products, refined from oil imported from the Middle East, were primarily re-exported as value-added products to neighboring African countries, particularly Uganda. Minerals accounted for about 5% of Kenya's exports to the United States. The United States received about 40% of Kenya's fluorspar production. Mineral-related imports from the United States included machinery and transport equipment, phosphate rock, and processed nonferrous minerals.

Mining was covered by the Mining Act, Chapter 306, of the Laws of Kenya. The 1940 Mining Act was under legislative review. Additionally, the mineral industry was covered by the Customs and Excise Act, the Foreign Investment Protection Act, the Income Tax Act, and the Value Added Tax Act.

Gold production was mainly artisanal. Auvista Minerals N.L., a subsidiary of Panorama Resources NL of Australia, was drilling the Migori gold prospect near Kiisi, about 400 kilometers (km) west of Nairobi. The Migori prospect was a joint venture with Mio Migori Mining Co. Ltd. of Kenya. Pan African Resources Corp. of Canada acquired a 75% interest in the Ndori gold prospect in southwestern Kenya from San Martin Mining and Investment Co. Ltd. of Kenya. San Martin continued to reprocess 50-year-old Kenyan gold mine dumps near Lake Victoria. (*See table 1.*)

World-class, titanium-bearing, heavy mineral sands resources were being evaluated along the coastline. Tiomin Resources Inc. of Canada began a prefeasibility study of the Mambrui prospect, about 125 km northeast of Mombasa. The company estimated that there was 650 million metric tons (Mt) of sand grading more than 3% titanium-bearing minerals (Tiomin Resources Inc., 1997a). Tiomin also was drilling the Sokoke prospect, about 50 km northeast of Mombasa. The company initially projected that ilmenite, rutile, and zircon would compose more than 3% of the 400 Mt of sands estimated to be in place at the Sokoke prospect (Tiomin Resources Inc., 1997b, p. 12).

Fluorspar is the second most important mineral after soda ash. It was produced from an open-pit mine at Cheberen in the Kerio Valley, near Eldoret. The former Government-owned Kenya Fluorspar Co. Ltd. operated the mine and produced acid-grade fluorspar that contained only 10% moisture. In 1996, Kenya Fluorspar was acquired by Minerals and Chemical Manufactures Ltd. of Kenya.

Soda ash was a significant source of foreign exchange earnings. Magadi Soda Co. Ltd., a subsidiary of Brunner Mond (U.K.) Ltd. of the United Kingdom, had a total soda ash production capacity of 300,000 metric tons per year. The Lake Magadi operation also was the largest source of crude salt in Kenya. Although much of the company's production was exported to Asia, the company was increasing exports to South Africa.

Kenya did not produce crude petroleum. Proceeds from petroleum products refined by Kenya Petroleum Refineries Ltd. in Mombasa made up a sizable share of Government revenues, as the Government owned 50% of the operation. Transportation of petroleum products from Mombasa to Nairobi was primarily via the pipeline of the Government-owned Kenya Pipelines Co. Ltd. The West Kenya pipeline extension, completed in 1994, transported petroleum products to terminals at Eldoret and Kisumu.

The Kenya Railways Corp. line runs from the west near Tororo, Uganda, passes through Nairobi, and terminates at the port of Mombasa, connecting key mining districts along the route. The road system was reportedly in poor condition, however, and electricity demand continued to outpace supply (Indian Ocean Newsletter, 1997).

Primarily derived from hydroelectric sources, usable electric generating capacity totaled about 784 megawatts (MW) of the 820-MW installed electric generating capacity. An additional 30 MW was imported from Uganda. Additional geothermal plants were under study. Proposed during 1996 were a 44-MW diesel-fueled plant at Nairobi and a 43-MW plant for Mombasa.

The outlook for the mineral industry of Kenya is good, with the Government continuing policies directed toward increasing domestic employment and foreign earnings through mineral production projects.

### References Cited

Indian Ocean Newsletter, 1997, British barometer: Indian Ocean Newsletter, no. 767, May 31, p. 6.

Ministry of Environment and Natural Resources, 1997, Mining investment opportunity in Kenya: Nairobi, Ministry of Environment and Natural Resources, 19 p.

Tiomin Resources Inc., 1997a, Tiomin makes a significant rutile/zircon discovery in Kenya: Toronto, Tiomin Resources Inc. press release, January 22, 1 p.

———1997b, Tiomin Resources Inc.: Toronto, Tiomin Resources Inc. investment pamphlet, 20 p.

## Other Sources of Information

Permanent Secretary
Ministry of Environment and Natural Resources
P.O. Box 30126
Nairobi, Kenya
Telephone: (254) 2-229-261

Mines and Geological Department
Madini House, Machakos Road
P.O. Box 30009
Nairobi, Kenya
Telephone: (254) 2-541-040

## TABLE I
## KENYA: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

| Commodity 2/ | | 1992 | 1993 | 1994 | 1995 | 1996 e/ |
|---|---|---|---|---|---|---|
| Aluminum, secondary e/ | | 2,000 | 2,400 | 2,400 | 2,400 | 2,400 |
| Barite | | 100 e/ | 14 | 20 | 20 e/ | 20 |
| Carbon dioxide gas, natural | | 4,802 | 5,910 | 5,605 | 7,982 | 9,119 3/ |
| Cement, hydraulic | thousand tons | 1,508 | 1,417 | 1,182 r/ | 1,122 r/ | 1,102 3/ |
| Clays, kaolin | | 21 | 7 | 69 r/ | 300 r/ | 595 3/ |
| Diatomite | | 507 | 829 | 592 | 457 r/ | 734 3/ |
| Feldspar e/ | | 1,200 | 1,200 | 1,200 | 500 r/ | 100 |
| Fluorspar (acid grade) | | 80,630 | 78,725 | 53,400 | 80,230 | 83,000 3/ |
| Gemstones, precious and semiprecious: | | | | | | |
| Amethyst | kilograms | (4/) | 303 | 303 e/ | 310 e/ | 300 |
| Aquamarine | do. | 100 | 43 | 14 | 50 e/ | 50 |
| Cordierite (Iolite) e/ | do. | 10 | 14 3/ | 15 | 15 | 15 |
| Garnet | do. | 90 | 31 | 42 | 119 | 120 |
| Ruby | do. | 123 | 120 e/ | 200 | 1,200 | 1,200 |
| Sapphire e/ | do. | 20 | 2,314 3/ | 2,310 | 2,300 | 2,300 |
| Tourmaline | do. | 10 | 229 | 43 | 224 | 250 |
| Gold, mine output, Au content | do. | 20 | 154 | 155 e/ | 170 e/ | 300 |
| Gypsum and anhydrite e/ | | 36,000 | 36,000 | 30,000 r/ | 28,000 r/ | 28,000 |
| Lead, mine output, Pb content | | 300 r/ e/ | 396 e/ | 350 | 4 | 5 |
| Iron and steel, steel, crude e/ | thousand tons | 20 | 20 | 20 | 20 | 20 |
| Lime e/ | | 12 000 | 12 000 | 12 000 | 12 000 | 15 000 |
| Petroleum refinery products e/ | thousand 42-gallon barrels | 17,000 | 17,000 | 16,200 r/ | 16,000 r/ | 16,000 |
| Salt, crude | | 102,000 e/ | 74,669 | 70,500 | 71,400 | 41,000 3/ |
| Soda ash | | 186,038 | 144,850 | 226,150 | 218,450 | 223,000 3/ |
| Stone, sand and gravel: | | | | | | |
| Coral e/ | thousand tons | 1,600 | 1,600 | 1,600 | 1,600 | 1,000 |
| Limestone | do. | 24 r/ | 25 r/ | 30 r/ | 31 r/ | 32 3/ |
| Sand, industrial (glass) e/ | | 12,300 | 12,300 | 12,300 | 12,300 | 13,000 |
| Shale e/ | | 115,000 | 115,000 | 95,000 r/ | 90,000 r/ | 88,000 |
| Vermiculite | | 2 291 | 1 961 | 1 113 e/ | , 457 | , 734 3/ |
| Wollastonite | | 100 e/ | 100 e/ | -- | -- | -- |

e/ Estimated. r/ Revised.

1/ Includes data available through Dec. 26, 1997.

2/ In addition to the commodities listed, a variety of industrial minerals and construction materials (brick clays, gravel, iron ore, kyanite, marble, crushed rock, and construction sand) are produced, but quantities are not reported and information is inadequate to make reliable estimates of output.

3/ Reported figure.

4/ Less than 1/2 unit.

## THE MINERAL INDUSTRY OF

# LIBYA

### By Bernadette Michalski

Lacking substantial industrial diversification, nearly 95% of Libya's revenues were attributed to the hydrocarbon sector. Libya's petroleum reserves were the largest on the African Continent but remained underexploited. Libya was, however, the second largest crude oil producer in Africa, following Nigeria. With the exception of the heavily subsidized Libyan Iron and Steel Co. (LISCO) which is supplied by imported raw materials, the nation's nonfuel mineral industry sector offered little contribution to the economy. Nonfuel mineral output was confined to the extraction of salt from the coastal plains near Benghazi and Tripoli, the quarrying of gypsum and limestone near Al Khums, and the extraction of clays. LISCO's iron and steel complex was operating at only about three-fourths of its design capacity of 1.2 million metric tons per year (Mt/yr).

As of yearend 1996, the Libyan Government had not complied with the United Nations' Security Council's request to extradite Libyan suspects in the Lockerbie, Scotland, airline bombing to either the United Kingdom or the United States. As a result, the economic sanctions against the Government of Libya were renewed. The United Nations resolutions called for the banning of sales to Libya of equipment used at oil and natural gas export terminals and refineries and the freezing of Libyan funds, with the exception of revenue derived from oil and gas sales. These resolutions against Libya originally promulgated in 1993 by the United Nations' Security Council fell short of a comprehensive oil embargo. Libya has slipped into isolation while the Lockerbie affair remains unresolved. The trade embargo imposed on Libya by the United States, the United Nations' sanctions, and the Libyan Government's strong opposition to the normalization of Arab relations with Israel nurtured that country's political and commercial isolation. European nations, such as Germany, Italy, and Spain, did not support a total oil embargo owing to their continuing heavy dependence on Libyan crude oil.

The Libyan legal system is based on Italian civil law and Islamic law. The nation operated a predominantly state-run, socialist economy, and the mineral industry was no exception. The Libyan National Oil Corp. (NOC), created by the Government in 1970 to oversee petroleum and natural gas exploration, production, and marketing, maintained complete control of Libyan oilfields and related investments, including marketing of all petroleum output.

Petroleum exploration and production sharing, along with any proposed mining activities, were based on the Fiscal Provisions, Revenue and Financial Law of July 1, 1977. A 1981 amendment defined production-sharing terms based on the following criteria: 85% to 15% in the Government's favor for highly significant hydrocarbon prospects, 81% to 19% for moderately significant oil prospects, and 75% to 25% for the least promising areas. An amendment followed in 1988 with revised terms that called for exploration costs to be recovered from output, with development costs to be equally split between the foreign operator and the NOC. The terms also called for production output to be shared between the contractor and NOC on a sliding scale and for tax and royalty exemption for the contractor.

Apart from hydrocarbons, mineral production in Libya was negligible. Activity was limited to the quarrying of gypsum, and limestone; and the extraction of clays. *(See table 1.)*

Hydrocarbons accounted for approximately 95% of total Libyan exports. In 1995, the total value of Libyan exports was $9.3 billion[1] and the total value of imports was $7.3 billion. Crude oil prices continued to improve in 1996. Libya exported 1.1 million barrels per day of petroleum in 1996. Italy remained Libya's largest single market receiving about 40% of crude oil exports.

About 1.5 million cubic meters of liquefied natural gas was exported in 1996 with Spain's Enagas as virtually the sole market.

The LISCO plant at Misurata, includes two 550,000-metric-ton-per-year (t/yr) Midrex direct reduction (DR) modules, six electric furnaces with a combined annual capacity of 1.25 Mt/yr, and a 140,000-t/yr cold-rolling mill. Although the plant has been operating below capacity, construction on a third DR module of 650,000 t/yr capacity began in 1995 with commissioning scheduled for 1998.

Natural gas production remained relatively stable in recent years; however, with the development of several new structures, production capacity could reach nearly 19 billion cubic meters by the year 2000. The Sirte Oil Co. currently produces over 10 billion m$^3$ annually from the Sirte basin. Italy's Azienda Generali Italiana Petroli S.p.A. (AGIP) in partnership with the NOC has undertaken the West Libyan Gas Development Project which will include the export gas from the Bouri Field to Italy. The field has a production potential of 6 billion cubic meters annually. The project also includes the development of the Wafaa Field with a production potential of 2 billion cubic meters annually, the construction of a gas treatment and separation facilities west of Tripoli, and a 1,040 kilometer (km) subsea gas pipeline to

---

[1] Where necessary, values have been converted from Libyan dinars (LD) to U.S. dollars at the rate of LD0.35=US$1.00.

Italy. The issuance of procurement tenders for the project was scheduled for 1997. The company is, however, hesitating on its large scale natural gas development project which should yield 8,000 $Mm^3$ annually for 30 years. AGIP has extensive interests in the United States and may be significantlyaffected by proposed sanctions on non-U.S. companies investing in the Libyan oil and gas sector. At mid year AGIP was hesitant to go further in case US sanctions would force it to freeze its $5.7 billion project.

AGIP remained the largest foreign operator in Libya by virtue of its 310,000 barrels per day (bbl/d) combined production from the Bu Attifel (170,000 bbl/d) and Bouri (140,000 bbl/d) Fields. Other significant foreign operators included France's Société National Elf Aquitaine and Germany's Veba AG and Wintershall AG. Libya continued to rely on foreign expertise and technical personnel to develop its petroleum industry. A consortium of European companies composed of Repsol of Spain, TOTAL SA of France, and OMV of Austria had the Murzuk Field in southwest Libya under development since October 1994. The first oil flowed from Murzuk in December 1996. Expected to produce eventually 250,000 bbl/d, the field contains a reserve of 800 million to I billion barrels of 43° API low-sulfur crude. Initial production has been scaled back in volume and time and is now anticipated in 1997 at 45,000 bbl/d. (Middle East Economic Digest, 1996). Domestic refining capacity was 342,000 bbl/d. Libya's three refineries in Europe have a combined capacity of 300,000 bbl/d bringing total refinery capacity at home and abroad to 642,000 bbl/d. Libya also has developed extensive distribution operations in its main European export markets—Italy, Germany, Switzerland, and the Netherlands. Distribution networks were established also in the Czech Republic, Hungary, Slovakia, and Spain. By the close of 1996, Libya's European distribution network included about 3,000 outlets.

Libya possessed the largest known crude oil reserves in Africa, estimated at 29.5 billion barrels. With the application of secondary and tertiary methods, the remaining recoverable reserves could total between 65 and 70 billion barrels. The Amal and Gialo Fields alone contain over 4 billion barrels of recoverable crude oil each. Total natural gas reserves in Libya were estimated by the NOC at 1.3 trillion cubic meters ranking third on the continent after Nigeria at nearly 3.5 trillion cubic meters and Algeria at 2.9 trillion cubic meters. (Arab Oil and Gas Directory, 1997). While Libya hosts other mineral resources, including gypsum, magnetite, phosphate rock, potash, sodium chloride, and sulfur, no figures for these reserves havebeen officially reported.

Transportation of petroleum and natural gas was primarily through a network of pipelines from wellhead to processing and shipping points that were primarily on the Mediterranean coast. Crude oil pipelines totaled 4,383 km, and natural gas pipelines totaled 1,947 km. Petroleum products traversed 443 km of pipeline. Libyan oil exports were conducted through six main terminals at Es-Sider, Marsa el-Brega, Tobruk, Ras Lanuf, Zawia, and Zueitina. Libya's General National Maritime Transport Co. operated a fleet of 25 vessels, which included 11 oil tankers with a total capacity of 1,321,700 deadweight tons.

Libya has been overlooked in the many new economic initiatives that are generating new prosperity for its North African and Mediterranean neighbors. In particular, the new Mediterranean trade zone is providing access to generous amounts of European Union funding for development. Furthermore, Libya's neighbors have launched successful privatization schemes to attract foreign investment and accelerate their economic development. In the long term, this could place Libya at a considerable competitive disadvantage. While Libya's export markets are relatively secure, earnings remain vulnerable to fluctuations in the price of oil, particularly since efforts to diversify its economy have not matched its ambitions.

## References Cited

Arab Oil and Gas Directory, 1997, Libya: Paris, Arab Petroleum Research Center, 264 p.

Middle East Economic Digest, 1996, Libya: Middle East Economic Digest, v. 40, no. 28, p. 12.

## Major Sources Of Information

Secretariat of Oil
P.O. Box 256
Tripoli, Libya
National Oil Corp.
P.O. Box 2655
Tripoli, Libya
Telephone: [218] 21 444-6181
Fax: [218] 21 333-1930

## TABLE 1
## LIBYA: PRODUCTION OF MINERAL COMMODITIES 1/

(Thousand metric tons unless otherwise specified)

| Commodity 2/ | | 1992 | 1993 | 1994 | 1995 | 1996 e/ |
|---|---|---|---|---|---|---|
| Cement, hydraulic | | 2,300 | 2,300 | 2,700 r/ | 3,210 r/ | 3,200 |
| Gas, natural: e/ | | | | | | |
| Gross | million cubic meters | 13,440 | 12,410 | 12,510 | 12,460 r/ | 12,450 |
| Dry | do. | 6,770 | 6,360 | 6,390 | 6,345 r/ | 6,330 |
| Gypsum e/ | | 180 | 160 | 180 | 180 | 180 |
| Iron and steel: | | | | | | |
| Metal: | | | | | | |
| Direct-reduced iron | | 846 | 944 | 852 | 963 r/ | 862 |
| Crude steel | | 822 | 920 | 874 | 909 r/ | 868 |
| Lime e/ | | 260 | 260 | 260 | 260 | 260 |
| Nitrogen: N content of ammonia | | 347 | 350 | 350 | 350 | 350 |
| Petroleum: | | | | | | |
| Crude | thousand 42-gallon barrels | 522,935 | 496,765 | 507,313 | 509,175 r/ | 511,000 |
| Refinery products: | | | | | | |
| Gasoline | do. | 15,330 | 15,480 | 16,000 | 15,500 r/ | 15,500 |
| Kerosene and jet fuel | do. | 13,870 | 13,578 | 13,800 r/ | 13;700 r/ | 13,700 |
| Distillate fuel oil | do. | 29,635 | 28,908 | 29,600 r/ | 29,000 r/ | 29,000 |
| Residual fuel oil | do. | 31,680 | 32,448 | 32,500 r/ | 32,000 r/ | 32,000 |
| Other | do. | 9,709 | 9,272 | 10,200 | 10,500 r/ | 10,500 |
| Total | do. | 100,224 | 99,686 | 102,100 r/ | 100,700 r/ | 100,700 |
| Salt | | 12 | 15 | 15 | 15 | 15 |
| Sulfur, byproduct of petroleum and natural gas e/ | | 14 | 14 | 14 | 14 | 14 |

e/ Estimated. r/ Revised.

1/ Table includes data available through Oct. 1, 1997.

2/ In addition to the commodities listed, a variety of construction stone, brick, and tile was produced, but available information was inadequate to make reliable estimates of output levels. Natural gas liquids were also produced but were blended with crude petroleum and were reported as part of that total.

### THE MINERAL INDUSTRY OF

# MADAGASCAR

### By George J. Coakley

The Republic of Madagascar, the world's fourth largest island, is located about 420 kilometers east of Mozambique in the Indian Ocean with an area of 581,540 square kilometers. In 1996, the area supported a population of 14 million and an estimated gross domestic product per capita of $880. Mining plays a secondary role to agriculture and fishing in the economy of Madagascar. The Malagasy mining industry is chiefly noted for its production and export of chemical and metallurgical grade chromite ore, high-quality crystalline flake graphite, and mica. In addition to these minerals, small quantities of gold and rare earths were produced, along with some industrial mineral commodities, including cement, feldspar, a variety of semiprecious gemstones, quartz and salt. Production of refined products from imported petroleum remained modest, while exploration for hydrocarbon resources continued. There is an active, but largely uncontrolled, artisanal gemstone mining sector, with known but unreported production of emeralds, sapphires, and other semiprecious stones. Estimates of 1996 production levels of all mineral commodities are shown on table 1. Environmental concerns continued to delay development of the ilmenite sands deposit near Toalagnaro discovered by QIT-Fer et Titane Inc. of Canada, a subsidiary of Rio Tinto Plc of the United Kingdom, while Phelps Dodge of the United States was actively exploring two nickel-cobalt deposits near Ambatovy and Analamay.

The chromite industry, located in Andriamena, is controlled by the parastatal Société Kraomita Malagasy. Graphite operations were owned and operated by five main companies, all headquartered in Antananarivo. Société Minière de la Grande Ile's Ambatomitamba graphite mine is the largest single producer. The other four operators are Etablissements Gallois, Société Louys, Etablissements Izouard, and Etablissements Rostaing. The Government had significant influence on foreign-owned mining operations through taxes, royalties, and official approval of all foreign exchange transactions.

The Office des Mines Nationales et des Industries Stratégiques (OMNIS) is involved primarily in research, joint ventures, and promotion of Madagascar's mineral resources, including hydrocarbons, and acts as the repository of the acquired exploration data. The Ministry of Energy and Minerals is primarily responsible for the energy sector.

For a more detailed description of the industry, see the 1995 Minerals Yearbook review. The next, more comprehensive industry review is scheduled for the 1997 edition. Please contact the U. S. Geological Survey Madagascar country specialist for more current information.

**Major Sources of Information**

Ministry of Energy and Mines
Geological Department
Boite Postale 322 Ampandrianomby
101 Antananarivo, Madagascar
Telephone: 261-2- 403-51
Office des Mines Nationales et des Industries
Stratégiques (OMNIS)
21 Lalana Razanakombana
Boite Postale 1 bis, Ambohijatovo
101 Antananarivo, Madagascar
Telephone: 261-2-242-83
Fax: 261-2-229-85
Telex: 261-2-223-70

### TABLE 1
### MADAGASCAR: PRODUCTION OF MINERAL COMMODITIES 1/

(Kilograms unless otherwise specified)

| Commodity 2/ | | 1992 | 1993 | 1994 | 1995 | 1996 e/ |
|---|---|---|---|---|---|---|
| METALS | | | | | | |
| Beryllium: beryl in quartz concentrates, industrial and ornamental e/ | | 3,000 | 3,000 | 3,000 | 31,666 r/ 3/ | 32,000 |
| Chromium: | | | | | | |
| Chromite concentrate, gross weight | metric tons | 69,123 | 60,900 | 42,700 | 49,702 r/ | 54,900 |
| Chromite ore, lumpy | do. | 91,700 | 83,300 | 47,500 | 56,405 r/ | 82,300 |
| Total | do. | 160,823 r/ | 144,200 | 90,200 | 106,107 r/ | 137,200 3/ |
| Gold, mine output, Au content e/ 4/ | | 500 | 500 | 500 | 38 r/ 3/ | 500 |
| Rare-earth minerals: e/ | | | | | | |
| Bastnasite (60% REO) | metric tons | 5 | 5 | 5 | 5 | 5 |
| Monazite (55% REO) | | 100 | 100 | 100 | 100 | 100 |
| INDUSTRIAL MINERALS | | | | | | |
| Abrasives, natural (industrial only) e/ | | 10,000 | 10,000 | 10,000 | 10,000 | 10,000 |
| Cement, hydraulic e/ | metric tons | 60,000 | 60,000 | 60,000 | 60,000 | 60,000 |
| Clay: Kaolin | do. | 756 | 700 e/ | 700 e/ | 1,545 r/ | 1,500 |
| Feldspar e/ | | 4,000 | 4,000 | 4,000 | 2,120 r/ 3/ | 2,000 |
| Gemstones: e/ 5/ | | | | | | |
| Amazonite | | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 |
| Amethyst: | | | | | | |
| Gem | | 1,700 | 1,700 | 1,700 | 1,700 | 1,700 |
| Geodes | | 80 | 80 | 80 | 80 | 80 |
| Graphite, all grades, shipments | metric tons | 8,910 | 11,200 | 12,715 | 16,119 r/ | 16,000 |
| Mica, phlogopite: e/ | | | | | | |
| Block | do. | 4 3/ | 4 | 4 | 1 r/ 3/ | 1 |
| Scrap | do. | 716 3/ | 700 | 700 | 389 r/ 3/ | 390 |
| Splittings and sheet | do. | 78 3/ | 70 | 70 | 42 r/ 3/ | 40 |
| Total | do. | 798 3/ | 774 | 774 | 432 r/ 3/ | 431 |
| Ornamental stones: e/ 6/ | | | | | | |
| Jasper | | 68,300 3/ | 68,000 | 68,000 | 68,000 | 68,000 |
| Labradorite | | 61,654 3/ | 61,000 | 61,000 | 61,000 | 61,000 |
| Quartz: e/ 7/ | | | | | | |
| Crystal | | 32,000 | 32,000 | 32,000 | 32,000 | 32,000 |
| Piezoelectric | | 66,000 3/ | 66,000 | 66,000 | 66,000 | 66,000 |
| Rose quartz | | 27,666 3/ | 27,000 | 27,000 | 27,000 | 27,000 |
| Smelting | | 180,000 | 180,000 | 180,000 | 180,000 | 180,000 |
| Salt, marine e/ | metric tons | 30,000 | 30,000 | 30,000 | 30,000 | 30,000 |
| Stone: e/ | | | | | | |
| Calcite, industrial | do. | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 |
| Dimension stone | do. | 3,000 | 3,000 | 3,000 | 3,000 | 3,000 |
| Marble, cipoline | | 1 | 1 | 1 | 1 | 1 |
| MINERAL FUELS AND RELATED MATERIALS | | | | | | |
| Petroleum refinery products: e/ | | | | | | |
| Gasoline | thousand 42-gallon barrels | 900 | 900 | 225 3/ | 450 | 450 |
| Kerosene and jet fuel | do. | 400 | 400 | 100 3/ | 200 | 200 |
| Distillate fuel oil | do. | 290 | 290 | 70 3/ | 140 | 140 |
| Residual fuel oil | do. | 500 | 500 | 125 3/ | 250 | 250 |
| Other | do. | 20 | 20 | 5 3/ | 10 | 10 |
| Total | do. | 2,110 | 2,110 | 525 3/ | 1,050 | 1,050 |

e/ Estimated. r/ Revised.

1/ Includes data available through December 1997.

2/ In addition to the commodities listed, modest quantities of unlisted varieties of crude construction materials (other clays, sand and gravel, and stone) presumably are produced, but output is not reported quantitatively, and available information is inadequate to make reliable estimates of output levels.

3/ Reported figure.

4/ Doesn not include an estimate of smuggled artisanal production.

5/ Reported output of other gemstones for 1996 in kilograms: Cordierite 3,942; Garnet 31,607; and Tourmaline 176,256.

6/ Other ornamental stones produced in 1996 for which data is reported in kilograms: Agate 9,335; Apatite 16,982; Aragonite 569; Calcite 43,419; Ruby 48,194; and Sapphire 94.

6/ Other forms of quatrz mined historically and estimated production in kilograms: Geodes 2,500; Hematoid 300; and other ornamental quartz 3,000.

### THE MINERAL INDUSTRY OF

# MALI

### By Philip M. Mobbs

Gold was the most economically significant mineral commodity produced in Mali during 1996. The country had a wide variety of other mineral deposits, but few have been developed because of a lack of infrastructure and local demand (United Nations, 1987). Gold accounted for more than 95% of the estimated total value of mineral commodities produced in Mali and about 18% of the country's total exports of goods of more than $400 million.[1]

Mali's geology is dominated by Precambrian rocks in the southwestern and central parts of the country and Paleozoic to Cenozoic rocks over most of the remainder. The Precambrian rocks host the mineral deposits that are of the greatest economic importance, particularly those in the Birimian Series greenstone belts near Kéniéba, Bougouni, and Sikasso. As elsewhere in west Africa, the greenstone belts host gold deposits, commonly within shear zones and quartz veins. Extensive gold exploration continued during the year, as did small-scale (artisanal) mining of gold and diamond. The Government estimated artisanal output of gold to be 2.2 metric tons per year (t/yr) (Direction Nationale de la Géologie et des Mines, 1996). *(See table 1.)*

Mining was overseen by the Direction Nationale de Géologie et des Mines, which is part of the Ministère des Mines, de l'Energie et de l'Hydraulique. The European Development Fund granted a $16.8 million Sysmin loan to the Ministry to upgrade the availability of existing geologic and mining information[2]. Proposed for the 4.5-year project to attract mineral investment were an aeromagnetic survey, the assembly of a geophysical data bank, and production of a series of 1:200,000-scale geologic maps.

The mining code included Decree No. 96-214/PM-RM of August 16, 1996, Ordonnance No. 91-065/P-CTSP of September 19, 1991, Decree No. 91-277/PM-RM of September 1991, and Decree No. 91-278/PM-RM of September 1991. Petroleum exploration and exploitation were regulated by Decree No. 30 of May 23, 1969, and by Decree No. 21, April 20, 1970. The Government had the right to 20% equity in all new mining ventures, of which 10% was a free share and the remainder a buy-in option. After 5 years of production, net profits were taxed at the rate of 35%. There was an ad valorem tax of 3% and a depletion allowance of as much as 27.5%(Ministère des Mines, de l'Energie et de l'Hydraulique, 1995).

The Malian gold rush charged ahead during 1996 despite an early drill core sample salting scandal. During January, Timbuktu Gold Corp. of Canada, formerly known as Choice Software Systems, acquired the Sitakili gold property. Drill results indicating values of up to 200 grams of gold per ton of ore announced in mid-April resulted in a spectacular runup of the company's stock price. Subsequent investigation by the Alberta Stock Exchange determined that there was "compelling evidence of deliberate sample enrichment" (Mining Journal, 1996; Northern Miner, 1996).

Four development permits were outstanding. La Société d'Exploitation des Mines d'Or de Sadiola, S.A. (Semos), began gold production at Sadiola Hill, about 80 kilometers (km) southwest of Kayes in western Mali, on December 20. Semos is a consortium of Anmercosa Mining (West Africa) Ltd. (38%), a subsidiary of Anglo American Corp. of South Africa; AGEM Ltd. of Barbados (38%), a subsidiary of International African Mining Gold Corp. of Canada; the Government of Mali (18%); and the International Finance Corp., a member of the World Bank Group (6%). Mine and plant construction entailed transport of more than 40,000 metric tons (t) of material along the railroad from Dakar, Senegal, and by road from Kayes.

Semos designed the Sadiola Hill Mine as a 12-year open-pit operation. The first processing line was projected to be at full 2-million-metric-ton-per-year (Mt/yr) capacity by February 1997. By May 1997, the second processing line was also expected to be processing 2 Mt/yr. Semos had projected an annual production of 12 t/yr of gold, significantly increasing Mali's annual gold output, with about 14 kilograms (kg) being produced in 1996 (IAMGOLD, 1997; Northern Miner, 1997). The company planned to import 190,000 barrels of diesel fuel per year to feed the plant's 12-generator [15-megawatt (MW)] powerplant. Semos anticipated a local workforce of 250, augmented by 50 expatriates. The mining contractor, Moolman Brothers of South Africa, was expected to employ about 120 people.

The Société des Mines d'Or de Syama, S.A. (Somisy), operated the gold mine at Syama, 75 km southwest of Sikasso. During October, Randgold Resources of Jersey, Channel Islands, a subsidiary of Randgold & Exploration Co. of South Africa, acquired BHP Minerals Mali, a subsidiary of the Broken Hill Proprietary Co. of Australia (BHP), for about $83 million. Included in the transaction were BHP's 65% interest in Somisy and 90% interest in the Morila and the Yanfolila exploration permits. BHP also divested its 20% option in the Société Minière de Loulo (Somilo) to Randgold. Somilo, a joint venture with the Government (41%) and LaSource of France (39%), had originally been formed in 1988 to develop the Loulo concession.

---

[1] Where necessary, values have been converted from Communauté Financière Africaine francs (CFAf) to U.S. dollars at the 1996 year end rate CFAf 525=US$1.00.

[2] Values were converted from European currency units (ECU) to U.S. dollars at the rate of ECU 0.918=US$1.00.

Somisy's new ownership will be Randgold Minerals Mali Inc. (65%), the Malian Government (20%), and the International Finance Corp. (15%). BHP had been confronted with a less-than-expected rate of return on its investment, labor unrest at the facility, and metallurgical problems as the mine transitioned to processing sulfide ore. Randgold reported that it had produced 1,292 kg of gold during its management tenure of the 4,386 kg produced at Syama during the year (Fleming Martin Securities Ltd., 1997; Randgold Resources, 1997).

On the basis of a study of the Kalana underground gold mine, the joint venture of Ashanti Goldfields Co. Ltd. of Ghana and Johannesburg Consolidated Investment Co. Ltd. of South Africa reportedly decided not to redevelop the mine (Nelson Gold Corp. Ltd., 1997).

A number of companies were active on exploration permits in the west along the frontier with Senegal. The area encompasses the Kéniéba gold district and the exploitation permits at Loulo and Sadiola. Afko International Inc., a subsidiary of Afko Korea Inc., undertook a feasibility study on its permit. Azco Mining Inc. of the United States and West African Gold and Exploration Ltd. of the British Virgin Islands, a joint venture of Eagle River International Ltd. of Vanuatu and Lion Mining Finance Ltd. of the United Kingdom, organized the Sanou Mining Corp. during 1996. Sanou held a 100% working interest in the Médinandi and the Dandoko concessions, which had been acquired from the Russian consortium, Guefest.

Emerging Africa Gold Inc. of Canada was evaluating the Kolomba-Mancouke, the Koulo, and the Narena permits. Etlin Ltd. of Australia drilled its Yatela gold permit, north of Sadiola. International Tournigan Corp. of Canada was exploring the Diangounte West property. Nevsun Resources Ltd. of Canada was drilling on the Tabakoto East concession. North of Tabakoto, Oliver Gold Corp. of Canada was funding the feasibility study of the Segala concession to earn 50% interest in the property from Consolidated Mining Corp. (West Africa) (CMCWA) of Mali. Trillion Resources Ltd. of Canada acquired 51% of CMCWA with 29% interest being retained by Consolidated Mining Corp of South Africa and 20%, by the Malian managing director.

Oxford Resources Inc. of Canada was evaluating the Sélou, the Dialafara-Rhama, and the Kéniéba group exploration permits. Pan African Resources Corp. of Canada (PARC) carried out a reverse circulation drilling program on the four-permit Dioulafoundou Property. PARC was also evaluating the Melgué and the Ouaiaga permits. Pangea Goldfields Inc. of Canada sampled the Fodie property, north of Sadiola.

Randgold was reconnoitering the Kérékoto property. Raymor Resources Ltd. of Canada acquired 85% interest in the Yeremounde gold property from COMIFA, S.A., of Mali. Ressources Robex Inc. of Canada acquired a 51% interest in the Diangounte and the Kata concessions from N'Gary Transport. Ressources Robex and Alpine Exploration Corp. of Canada were evaluating the Baroya concession with SOMEX S.A.R.L. of Mali. Reunion Mining plc of the United Kingdom was exploring SONAREM's optioned Sanoukou exploration permit. Sadiola Exploration Ltd. of the British Virgin Islands (SADEX) was a 50-50 joint venture of Anmercosa and AGEM. SADEX drilled the Dinnguilou and the Farabakouta prospects and was evaluating the Alamoutala concession in the Sadiola I permit area, adjacent to the Sadiola Hill Mine.

Companies with exploration permits for the Kangaba, the Kalana, and the Syama regions south of Bamako included Alagona Trading, Anmercosa, and Barrick Gold Corp. Mink Mineral Resources Inc. of Canada was evaluating its Niaouleni gold concession. Oxford was studying its permit area in the Kangaba region. Pacific Galleon Mining Corp. of Canada acquired interest in the Finkolo concession and an option on the Niena concession, north of the Syama Mine. Pangea Goldfields was evaluating its Foulaboula property. Sahelian Goldfields Inc. of Canada, formerly McNickel Inc., assembled the Kourémalé-Salémalé property from six nonrenewable local prospection authorizations. Sodinaf S.A. of Mali was evaluating its Kodieran prospect. Young Poong Mining and Construction of Korea completed its initial reconnaissance program on the Gouenso gold project.

Diamonds were recovered as byproduct by artisanal gold miners. However, the Mali Diamond Exploration B.V. joint venture of Ashton West Africa Pty. Ltd. of Australia (51% interest) and Mink Mineral Resources (49%) proposed the establishment of a large-scale diamond operation. Ashton was sampling the Kéniéba-area diamond prospect for the venture.

Mali's transportation infrastructure was underdeveloped and has proven to be a deterrent to mineral exploration and development. The highway network totaled about 15,700 km, mostly in the south. The 1,286-km railroad connecting Bamako, Mali with Dakar included a 642-km segment through Mali. The railroad and the major roads to Côte d'Ivoire were used to import mineral-related products, particularly fuels, as well as equipment and supplies. Mali's electrical grid was inadequate to service mineral development. The gold rush and subsequent anticipated development activity will strain Mali's electrical power deliverability. The Government was seeking funding to rehabilitate the 44-MW Selingué Dam and to develop the Manantali hydroelectric generating station on the Senegal River.

Development of Mali's mineral resources was hindered by the country's general lack of infrastructure and local markets. The end of the 4-year Tuareg war should open northern and eastern Mali to mineral exploration.. Gold will likely continue to dominate the country's mineral economy with current exploration efforts likely to lead to development of additional gold deposits by the turn of the century. Annual gold output is forecast to increase to almost 18 t in 1997 and to exceed 20 t by 1998.

## References Cited

Direction Nationale de la Géologie et des Mines, 1996, Gold in Mali—A new investment opportunity: Bamako, Direction Nationale de la Géologie et des

Mines, 4 p.

Fleming Martin Securities Ltd., 1997, Randgold Minerals Mali Inc.—Opportunity abounds: Johannesburg, Fleming Martin Securities Ltd., February 3, 13 p.

IAMGOLD, 1997, IAMGOLD issues 1997 first quarter results: Markham, Ontario, Canada, IAMGOLD press release, May 29, 2 p.

Mining Journal, 1996, Sitakili salting: Mining Journal, v. 326, no. 8382, June 14, p. 460.

Ministère des Mines, de l'Energie et de l'Hydraulique, 1995, The statutory rule of the mining sector and the given opportunities for the private investors in Mali: Bamako, Ministère des Mines, de l'Energie et de l'Hydraulique, 8 p.

Nelson Gold Corp. Ltd., 1997, Nelson Gold completes an agreement in principle with Ashanti Goldfields for the purchase of a 70 percent stake in the Kalana Gold Mine and concession (Mali): Business Wire, May 21, 1997. (Accessed October 27, 1997, on the World Wide Web at URL http://biz.yahoo.com/bw/97/05/21/nlg_y0023_1.html)

Northern Miner, 1996, Timbuktu resumes trading on ASE: Northern Miner, v. 82, no. 40, December 2, p. A11.

———1997, Sadiola Hill approaches 330,000–oz. target: Northern Miner, v. 83, no. 12, May 19, p. A1.

Randgold Resources, 1997, Report for the quarter ended 31 December 1996: Johannesburg, Randgold Resources, 2 p.

United Nations, 1987, Mineral resources of Mali: New York, United Nations UNDP/DTCD MLI/85/007 Project, 64 p.

## Major Sources of Information

Direction Nationale de la Géologie et des Mines
B.P. 223
Bamako, Mali
Telephone: (223) 224-184, (223) 225-821
Fax: (223) 222-160, (223) 229-111

Société Nationale de Recherches et d'Exploitation des Ressources Minières du Mali
B.P. 2
Kati (Bamako), Mali
Telephone: (223) 224-184, (223) 272-049
Fax: (223) 222-160, (223) 272-042

TABLE 1
MALI: ESTIMATED PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

| Commodity 2/ | | 1992 | 1993 | 1994 | 1995 | 1996 |
|---|---|---|---|---|---|---|
| Cement, hydraulic | | 20,000 | 20,000 | 15,000 r/ | 13,000 r/ | 15,000 |
| Gold, mine output, gold content 3/ | kilograms | 5,700 | 5,500 | 6,200 r/ | 7,800 | 8,400 |
| Gypsum | | 700 | 700 | 500 r/ | 450 r/ | 500 |
| Phosphate | | 2,000 | 2,000 | 1,039 | 3,000 | 3,000 |
| Salt | | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 |
| Silver 4/ | kilograms | 200 | 190 | 200 r/ | 250 r/ | 270 |

1/ Includes data available through Oct. 1997.

2/ In addition to the commodities listed, Mali produced clays, stone, and sand and gravel for local construction purposes in addition to diamond an tin, but information is inadequate to make reliable estimates of output levels.

3/ Includes estimate of artisanal production.

4/ Estimated silver content of doré bullion.

# THE MINERAL INDUSTRY OF

# MAURITANIA

## By Bernadette Michalski

Iron ore mining and beneficiation was the dominant mineral industry in Mauritania and has accounted for approximately one-third to one-half of export earnings since the mid-1980's. Gold recovery from the Akjoujt copper mine tailings was drawn to a close in early 1996 as the tailings stockpile was depleted. Cement and salt also were produced. The nation's sole petroleum refinery, operating on imported crude oil, supplied about one-half of the country's petroleum product requirements. Mining accounted for more than 12% of the gross domestic product (Afrafa, 1997). The Ministry of Mines and Industry's Office of Geological Research continued several exploration programs during 1996. Principal activities were focused on gold exploration in the Tassiast, Tijirit, and Inchiri regions.

Production of the nation's foremost mineral commodity, iron ore, improved with the opening of the M'Haoudat Mine in 1994 which for the most part provided direct shipping ores averaging 65% iron content. *(See table 1.)* Salt is recovered from coastal areas near Nouakchott. Production, however, does not meet the heavy requirements of the fish processing industry.

Mauritania's iron ore shipments totaled nearly 11.16 million metric tons (Mt) in 1996, a 3.1% reduction from that of 1995. About 8.9 Mt were exported as fines and the remainder as lump ore. Most exports, or 10.8 Mt, were delivered to the steel mills of the European Union with Italy as the leading destination. Iron ore accounted for 40% of total exports in 1996. Other mineral exports were possibly small quantities of gold and plaster products.

Petroleum product imports were approximately 1.5 million barrels in 1996, accounting for almost one-half of consumption; the remainder was supplied from the refining of imported crude oil. Other mineral industry imports included about 125,000 metric tons per year (t/yr) of aluminum and copper semimanufactures, 3,000 t/yr of sulfuric acid, 2,000 t/yr of phosphate fertilizer, and about 12,000 t/yr of salt.

Ashton Africa Ltd. of Australia obtained several permits in the Tassiast and R'Gueibat shield for diamond exploration. Although commercially promising phosphate rock deposits have been discovered in remote regions of southern Mauritania, lack of essential infrastructure continues to hamper their development.

Australia's General Gold Resources NL was awarded an exploration license covering an additional 3,000 square kilometers (km$^2$) in the Tassiast-Tijirit region north of Akjoujt bringing the company's total area under exploration licenses for copper-gold-cobalt resources to 23,000 km$^2$. General Gold Resources NL is also developing the Guelb Moghrein copper mines in partnership with Société Arab des Mines de l'Inchiri (SAMIN). A feasibility study by Kilborn and Lavalin of Canada reports a minable reserve of 22 Mt averaging 1.8% copper. Extraction of the near-surface-oxide ore is to commence in 1998 and continue for a projected 13-year mine life. Total output from the mine is expected to be 325,000 metric tons of copper; 26,000 kilograms of gold; and 2,600 metric tonst of cobalt in hydroxide powder form (General Gold Resources, 1997).

Iron ore mining operations were conducted by Société Nationale Industrielle et Minière (SNIM) in northwestern Mauritania. More than one-half of the production is derived from the M'Haoudat deposit, 60 kilometers (km) northeast of Zouirat.

The Alexandria National Iron & Steel Co. and the Holding Co. for Metallurgical Industries, of Egypt, along with Enterprise Nationale de Siderurgie and Ferphos, of Algeria, have joined SNIM in signing a protocol agreement on the construction of an iron ore pelletizing plant to satisfy demands of direct-reduction plants in the region. The plant's capacity was planned at 5 million metric tons per year (Mt/yr) of iron ore pellets upgraded to a 68% iron content. The project involves mining and beneficiation at Ayouj, 30 km north of F'Derik and 650 km from the Port of Nouadhibou.

In September 1996, a 42,645 km$^2$ hydrocarbon exploration permit was awarded to Hardman Resources of Australia. This was the first active hydrocarbon exploration program since 1993.

Mauritania's sole petroleum refinery, Nouadhibou, was owned by the Société Mauritanienne d'Industrie de Raffinage and operated under the technical management of Algeria's Naftal. The 20,000-barrel-per-day capacity refinery, operating on imported crude oil, supplied more than one-half of Mauritania's petroleum product requirements.

Iron ore reserves, according to SNIM are 155 Mt of hematite ore ranging from 60% to 68% iron and 531 Mt of magnetite ore ranging from 36% to 40% iron (Société Nationale Industrielle et Minière, 1997). In addition to these proven reserves, probable iron ore reserves in the western Guelbs amount to 980 Mt of low grade ores.

A major barrier toward investment and development was the nation's limited infrastructure, which renders all but the largest deposits uneconomic. There were four paved roads in Mauritania: from the port of Nouakchott to the copper deposits at Akjoujt in the north, from Nouakchott to Nema in the east, from Nouakchott to Rosso in the south, and from Boghe to Kaedi on the southern border. The sole railroad in Mauritania was owned and operated by SNIM for the transport of iron ore from the mines to the export terminal. The 1.435-meter standard-gauge railroad extends more than 700 km from M'Haoudat to the port at Nouadhibo.

Existing and proposed mining operations suggest an improved outlook for the nation's economy. Increased production, however, is largely dependent on world iron ore prices. Factors bearing on the availability of financial support for the mineral economy include the border disputes between the Governments of Senegal and Mauritania, the nation's heavy external debt burden, and significant fiscal balance-of-payments deficits.

Mauritania, assisted by the World Bank, was preparing to overhaul its mining sector policies to attract more foreign investment with the objective of diversifying the economic base and increasing employment while strengthening the technical skills of the labor force. The Ministry of Mines and Industry was revising the mining code and reinforcing and restructuring the state institutions involved in mining and geology. The mining code revision was scheduled to be part of a major reform of the Nation's judicial and regulatory systems slated for completion by 1997.

## References Cited

Arafa, M'Boye, 1997, Note on mining sector: Islamic Republic of Mauritania, Ministry of Mines and Industry, Directorate of Mines and Geology, 9 p.

General Gold Resources, 1997, Quarterly report—1997: West Perth, Australia, p. 1., General Gold Resources N.L

Société Nationale Industrielle et Minière 1997: Mauritania, Nouakchott, Mauritania, Société Nationale Industrielle et Minière 4 p.

## Major Sources of Information

Mauritanian Office for Geological Research (OMRG)
B.P. 65
Nouakchott, Mauritania
Telephone: [222] (2) 514-10
Ministry of Mines and Geology
B.P. 199
Nouakchott, Mauritania
Telephone: [222] (2) 532-25
Société Nationale Industrielle et Minière (SNIM)
R.C. No. 4579
Nouakchott, Mauritània
Fax: [222] (2) 453-96

TABLE 1
MAURITANIA: PRODUCTION OF MINERAL COMMODITIES 1/

| Commodity 2/ | | 1992 | 1993 | 1994 | 1995 e/ | 1996 e/ |
|---|---|---|---|---|---|---|
| Cement | metric tons | 122,000 | 111,000 | 374,000 | 375,000 | 375,000 |
| Gold | kilograms | 826 | 1,264 | 1,738 | 1,196 r/ | 200 |
| Gypsum | metric tons | 3,300 | 3,240 | 4,230 | 5,810 r/ | 9,300 |
| Iron and steel: Iron ore: | | | | | | |
| Gross weight | thousand metric tons | 8,835 | 9,360 | 11,400 | 11,610 r/ | 11,360 |
| Iron content e/ | do. | 5,330 | 5,700 | 7,000 | 7,000 | 7,000 |
| Petroleum refinery products: | | | | | | |
| Liquefied petroleum gas | thousand 42-gallon barrels | 441 | 418 | 415 e/ | 415 | 415 |
| Gasoline | do. | 1,912 | 1,938 | 1,925 e/ | 1,925 | 1,925 |
| Kerosene | do. | 448 | 471 | 470 e/ | 470 | 470 |
| Distillate fuel oil | do. | 1,129 | 1,099 | 1,100 e/ | 1,100 | 1,100 |
| Residual fuel oil | do. | 2,344 | 2,357 | 2,355 e/ | 2,355 | 2,355 |
| Other | do. | 636 | 635 | 640 e/ | 640 | 640 |
| Total | do. | 6,910 | 6,918 | 6,905 e/ | 6,905 | 6,905 |
| Salt e/ | metric tons | 5,500 | 5,500 | 5,500 | 5,500 | 5,500 |

e/ Estimated. r/ Revised.

1/ Table includes data available through Sept. 1, 1997.

2/ In addition to the commodities listed, modest quantities of crude construction materials (clays, sand and gravel, and stone) presumably were produced, but output was not reported quantitatively, and available information was inadequate to make reliable estimates of output levels.

### THE MINERAL INDUSTRY OF

# MOROCCO AND WESTERN SAHARA

### By Bernadette Michalski

Morocco is the world's third largest producer of phosphate rock, following the United States and China. The nation is also a modest producer of antimony, anthracite coal, barite, cobalt, copper, fluorspar, iron ore, lead, manganese, salt, silver, and zinc. The mineral industry is Morocco's largest foreign exchange earning sector and usually accounts for about 6% of the gross domestic product. Current mining legislation in Morocco is based on Mining Code Bill No. 1-73-412 of August 13, 1973. A 1990 revision to the mining law required the Government to respond within 2 months to any foreign investment proposal; and, if not, the contract presumably would be null and void. Generally, all mining law revisions were intended to expedite the Government approval process. Regulations concerning the management of petroleum and natural gas resources were revised in 1992 to provide further incentives for international companies. The revised law reduced the Government's share in agreements with international operators from 50% to 35%. Exploration activity would be fully deductible for more than 10 years for new contracts and more than 3 years for preexisting operators in Morocco. Furthermore, the petroleum duty was waived covering the initial 3 years of production. No royalty is payable on the first 4 million tons (about 30 million barrels) of output from any concession. To complement these new measures, exploration permit sizes were reduced from 5,000 square kilometers ($km^2$) to a minimum of 200 $km^2$ and a maximum of 2,000 $km^2$. Maximum total holdings are limited to 10,000 $km^2$ onshore and 20,000 $km^2$ offshore for each company. The minimum duration of an agreement was reduced from 15 years to 8 years. Concessionaires are not required to contribute a share of output to domestic needs. In 1992, the Government abrogated the 1974 Moroccanization law, which pertained to petroleum refining and distribution. These latter legal changes were designed to allow foreign companies to participate in the privatization of parastatals in the petroleum sector.

The Government has placed 114 diverse enterprises on a privatization list. The state's interests in metal and industrial mineral enterprises were represented by the Bureau de Recherches et de Participations Minières (BRPM). Government equities offered for privatization included Société Metallurgique d'Imiter's (SMI) silver mine with capital of $11.2 million, of which the Government owned 69%; and Compagnie de Tifnout Tiranimine (CTT) with a capital value of $312,000, of which 40% was Government owned; a fluorite mine of Société Anonyme d'Entreprises Minières (SAMINE) capitalized at $4 million, of which the Government held a 35% equity share; and the Société Minière de Bou Gaffer (SOMIFER) copper mine which was capitalized at $10.3 million, of which the Government held a 34.2% equity. The Government also offered 26% of a lead mine of the Société de Fonderies de Plomb de Zalidge with capital of $2.7 million and, lastly, the 43% of Société Anonyme Chérifienne d'Etudes Minières, (SACEM), which exploited the manganese mine of Imini in Quarzazate. With the exception of SMI, as of yearend 1996, little interest for these properties from international mining companies was evidenced, and the Ministry of Privatization initiated negotiations with Moroccan companies with the objective of meeting privatization goals by 1998. The privatization program included the sale of 30% of the Government's equity in the Samir Petroleum Refining Co. which raised $160 million in 1996.

The most pressing environmental issue in Morocco was the pollution of the drinking water supply in the country's two most important river basins, the Sebou Basin and Qum Er Rabia Basin, from domestic, industrial, and agricultural sources. Silting of dams and the deterioration of other existing water infrastructure were a major concern. Therefore, the World Bank recommended that investments should be made in repairing existing structures as opposed to financing new projects.

Although Morocco produced a variety of minerals, it is phosphate rock and fertilizers, including phosphoric acid, diammonium phosphate, and triple superphosphate that remain significant on a global scale. *(See table 1.)*

Morocco is the world's foremost exporter of phosphate rock and phosphoric acid. Phosphates account for more than 30% of all Moroccan exports and 70% of the mineral exports, which also include copper, iron ore, lead, and zinc. Phosphate exports exceeded 10 million metric tons (Mt) in 1996 with Spain, the United States, and Mexico as the principal markets by order of volume. Copper concentrate exports totaled 41,000 metric tons (t), most of which were delivered to Spain. Lead concentrate exports totaled 45,700 t, while unwrought lead metal totaled 55,000 t. Zinc concentrate exports totaled 178,200 t, all of which were delivered to the European Union with Spain, Belgium-Luxembourg, and France as the principal markets by order of volume.

The major mineral commodity import continues to be crude oil and petroleum products, which totaled more than 55 million barrels in 1996. The principal source for imported crude oil was Saudi Arabia. Algeria was the principal source for liquefied petroleum gas. Other imported mineral commodities included sulfur and solid fuels. Morocco imported more than 2.6 Mt of sulfur in 1996 with Canada, Saudi Arabia, and Poland as the principal sources by order of magnitude. Coal and coke imports totaled more than 2.2 Mt—mostly from the United States.

The mining industry of Morocco is controlled by the Government, specifically the Directorate of Mines, which is a department of the Ministry of Energy and Mines. The

Directorate of Mines is charged with the interpretation and application of the national mining policy. The Directorate also controls the various parastatals and public companies involved in the mining industry. The Directorate of Mines also manages mining properties; labor concerns; commercialization; and studies in mining, mineralogy, and metallurgy.

Established in 1928, BRPM is an autonomous public corporation involved directly or indirectly in the majority of all Moroccan mining enterprises, excluding hydrocarbons and phosphate. BRPM employed about 1,330 people, including 150 engineers. Founded in 1920, the parastatal Office Cherifien des Phosphates (OCP) manages and controls phosphate mining. OCP controls all aspects of the phosphate industry in Morocco, including research, exploitation, and the production of derivative products, such as fertilizers. In 1996, OCP employed about 30,000 people, including some 700 engineers and technicians. Created in 1960, La Centrale d'Achat et de Développement de la Région Minière de Tafilalet et de Figuig (CADETAF) promotes the working of artisanal mines of barite, lead, and zinc in the regions of Tafilalet and Figuig. CADETAF provides technical, commercial, and social assistance to the artisanal miners. The Government parastatal that controls hydrocarbon exploration and production is the Office National de Recherches & d'Exploitations Petrolieres.

Omnium Nord Africain (ONA) is the largest private company in Morocco. The company was active in four areas: agricultural distribution, finance, mining, and technology. ONA's mining subsidiary, Pole Mines, was involved in four significant Moroccan mining ventures. Pole Mines' equity ventures included the polymetallic Douar Hajar Mine with Cie. Minière de Guemassa, the Bleida copper mine with SOMIFER; the cobalt mine at Bou Azzer operated by CTT; and the El Hammam fluorite mine operated by SAMINE. All of the latter joint ventures were with BRPM. The only other joint venture in which Pole Mines was not the sole operator is the silver mine at Imiter, operated by SMI with equity ownership by BRPM. Pole Mines also was involved in chemicals, engineering, contracting, mineral exploration, and transport. *(See table 2.)*

The Société d'Exploitation des Mines du Rif discontinued mining iron ore in mid-1996. Four remaining iron ore deposits have been identified in the area with an iron content averaging 58% but with a high sulfur content. BRPM plans to issue tenders for the exploitation and pelletizing of the ores from these deposits in 1997 (Metal Bulletin, 1997).

The public offering of 35% of the Moroccan parastatal Société Nationale de Sidérurgie's (SONASID) steel mill in Nador was oversubscribed. In 1996, the mill produced about 400,000 t of steel rebar and wire rod for the domestic market. SONASID stated that it must import about 450,000 metric tons per year (t/yr) of iron and steel billet to meet its requirements. The billet was imported primarily from Italy, Portugal, and Poland. The Government considered offering for sale additional equity in the company to provide capital for upgrading the mill with an electric arc furnace and a continuous caster.

OCP's Sidi Chennane phosphate rock mine became operational by yearend 1995 and is expected to have a capacity of 5 million metric tons per year (Mt/yr) by 1998. It will replace older mines now approaching depletion.

Morocco has developed a significant capacity for conversion of phosphate rock into downstream chemicals. OCP operated its facilities at 95% of capacity in 1996. OCP plans for debottlenecking existing facilities should result in a 10% to 15% increase in the phosphate chemicals output by yearend 1997.

Domestic crude oil production was negligible, while the domestic consumption rate was steadily rising. Crude oil and petroleum product import costs approached $1 billion per year. The refineries at Mohammedia and Sidi Kacem together processed nearly 50 million barrels (Mbbl) of petroleum products in 1996. Both refineries have been slated for privatization.

In 1996, reserves of phosphate rock totaled 85.5 billion tons; coal, 17.5 Mt; copper, 8.4 Mt; lead, 10.7 Mt; and zinc, 8 Mt. Crude oil reserves were reported at 1.2 Mbbl and natural gas at 1.1 billion cubic meters.

The railroad network in Morocco totaled 1,893 kilometers (km) of 1.435-meter standard-gauge single track. The highway infrastructure totaled 59,198 km, of which 27,740 km was paved. Crude oil pipelines totaled 362 km, and natural gas pipelines totaled 241 km. Morocco's merchant marine fleet comprised 51 ships totaling 487,479 deadweight tons. Of these ships, there were 3 petroleum tankers and 11 chemical tankers. Major Moroccan ports are at Agadir, Casablanca, Jorf Lasfar, Kenitra, Mohammedia, Nador, Safi, and Tangier. The nation's electrical generation capacity was 2,384 megawatts.

In assessing Morocco's economic performance, the International Monetary Fund (IMF) concluded that the country had made significant strides in restoring its financial balances. Morocco has been pursuing an active structural adjustment strategy since 1983 under the supervision of the IMF. The privatization program that began in 1993, with the intention of transferring resources from the public sector to the private sector to promote business investment, has met limited success. The public offering of the Société Marocaine de l'Industrie du Raffinage's petroleum refinery and the Sonasid rebar and wire mill was oversubscribed; while international mining interest in metal mines was negligible. The economy is expected to improve markedly with the 1997 entry of Morocco into the planned free trade zone with the European Union, which will award grants and loans to assist the private sector in modernization and expansion activities.

## Reference Cited

Metal Bulletin, 1997, Morocco: Metal Bulletin, no. 8164, March 24, p. 23.

## Major Sources of Information

Association des Services Geologiques Africains
M. Beisaid, Institut de Geologie, Nouveau
Quartier Administratif
Agdal-Instituts, B.P. 6208
Rabat, Morocco

Bureau de Recherches et de Participations
Minières (BRPM)
5 Avenue Moulay Hassan
B.P. 99
Rabat, Morocco
Telephone: (07) 70-50-05

Fax: (07) 70-94-11
Direction de la Geologie
Rabat-Institut, B.P. 6208
Rabat, Morocco
Telephone: (07) 77-28-24
Fax: (07) 77-79-43
Groupe Office Chérifien des Phosphates (OCP)
Angle route d'El Jadida et boulevard de la Grande Ceinture
Casablanca, Morocco
Telephone: (02) 23-00-25
Fax: (02) 23-06-35
Groupe ONA
52 Avenue Hassan II
Casablanca, Morocco
Telephone: (011) 212-2-224102
Fax: (011) 212-2-261064
Ministère de l'Energie et des Mines
5 Rue de Rich, Tour Hassan
Rabat, Morocco

**Major Publications**

Ministère de l'Energie et des Mines, Direction des Mines
Activite du Secteur Minière 1994
Rabat, Morocco. May 1996.
Bureau de Recherches and de Participations Minières
Rapport Annuel 1996
Rabat, Morocco 1997.

## TABLE 1
## MOROCCO AND WESTERN SAHARA: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

| Commodity 2/ | 1992 | 1993 | 1994 | 1995 | 1996 e/ |
|---|---|---|---|---|---|
| METALS | | | | | |
| Antimony concentrate: | | | | | |
| Gross weight | 438 | 369 | 523 | 442 | 345 3/ |
| Sb content | 197 | 167 | 235 | 198 | 152 |
| Chromite | 302 | -- | -- | -- | -- |
| Cobalt concentrate: | | | | | |
| Gross weight | 4,253 | 3,606 | 3,810 | 4,885 | 5,040 3/ |
| Co content | 467 | 397 | 419 | 537 | 565 3/ |
| Copper: | | | | | |
| Concentrates, gross weight | 34,297 | 35,690 | 36,010 | 35,952 r/ | 37,623 3/ |
| Matte, gross weight | 2,177 | 1,548 | 1,689 | 1,933 r/ | 1,671 3/ |
| Cu content, concentrates and matte | 14,317 | 13,746 | 14,000 | 14,100 r/ | 14,550 3/ |
| Gold e/ kilograms | 500 | 600 | 565 3/ | 580 | 580 |
| Iron and steel: | | | | | |
| Iron ore: | | | | | |
| Gross weight | 82,625 | 66,318 | 63,517 | 47,192 r/ | 12,324 3/ |
| Fe content | 51,225 | 41,117 | 39,380 | 31,518 r/ | 8,257 3/ |
| Metal: e/ | | | | | |
| Pig iron | 15,000 | 15,000 | 15,000 | 15,000 | 15,000 |
| Steel, crude | 7,000 | 7,000 | 7,000 | 7,000 | 7,000 |
| Lead: | | | | | |
| Concentrate: | | | | | |
| Gross weight | 104,940 | 111,896 | 104,520 | 101,631 r/ | 107,577 3/ |
| Pb content | 59,600 | 81,680 | 73,160 | 67,708 r/ | 71,667 3/ |
| Cupreous matte, Pb content | 566 | 402 | 442 | 500 e/ | 500 |
| Metal: | | | | | |
| Smelter, primary only | 68,585 | 69,110 | 60,740 | 62,363 r/ | 61,749 3/ |
| Refined: | | | | | |
| Primary | 68,500 | 69,100 | 60,700 | 50,000 e/ | 50,000 |
| Secondary e/ | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 |
| Total e/ | 70,500 | 71,100 | 62,700 | 52,000 | 52,000 |
| Manganese ore, largely chemical-grade | 49,120 | 42,600 | 31,452 | 31,263 r/ | 29,466 3/ |
| Silver: | | | | | |
| Ag content of concentrates and matte kilograms | 69,386 | 73,355 | 68,500 | 22,000 r/ | 19,304 3/ |
| Ag content of mine and smelter bullion do. | 143,900 | 235,800 | 257,000 | 182,000 r/ | 180,291 3/ |
| Total do. | 213,286 | 309,155 | 325,500 | 204,000 r/ | 199,595 3/ |
| Zinc concentrate: | | | | | |
| Gross weight | 42,649 | 125,737 | 147,213 | 153,125 r/ | 152,580 3/ |
| Zn content | 22,603 | 65,378 | 76,800 r/ | 79,900 r/ | 79,650 3/ |
| INDUSTRIAL MINERALS | | | | | |
| Barite | 401,599 | 325,200 | 264,526 | 289,308 r/ | 288,045 3/ |
| Cement, hydraulic thousand tons | 6,340 | 6,350 e/ | 6,350 e/ | 6,401 r/ | 8,000 |
| Clays, crude: | | | | | |
| Bentonite | 7,273 | 10,802 | 24,919 | 29,308 | 29,881 3/ |
| Fuller's earth (smectite) | 38,098 | 38,700 | 22,800 | 15,027 r/ | 16,673 3/ |
| Montmorillonite (ghassoul) | 2,670 | 2,440 | 3,329 | 3,311 r/ | 3,169 3/ |
| Feldspar e/ | 1,000 | 1,000 | 1,000 | 17,233 r/ | 833 |
| Fertilizers thousand tons | 2,200 | 2,600 | 2,000 | 2,100 | 2,200 |
| Fluorspar, acid-grade | 85,500 | 70,050 | 85,000 | 105,800 r/ | 100,000 |
| Gypsum e/ | 450,000 | 450,000 | 450,000 | 450,000 | 450,000 |
| Mica e/ | 1,500 | 1,500 | 1,500 | 564 r/ 3/ | 600 |
| Phosphate rock (includes Western Sahara) thousand tons | 19,146 | 18,305 | 20,375 | 20,684 r/ | 20,855 3/ |
| P2O5 content do. | 6,180 | 5,920 | 6,580 | 6,399 r/ | 6,552 3/ |
| Phosphoric acid do. | 2,600 | 2,501 | 2,603 | 2,600 | 2,500 |
| Salt: | | | | | |
| Rock | 164,528 | 103,525 | 142,258 | 137,910 | 138,290 3/ |
| Marine | -- | 50,900 | 45,600 | 42,300 | 32,530 3/ |
| MINERAL FUELS AND RELATED MATERIALS | | | | | |
| Coal, anthracite | 575,900 | 603,800 | 650,400 | 649,600 | 505,600 3/ |
| Gas, natural: | | | | | |
| Gross million cubic meters | 20 | 38 | 25 | 17 | 17 |
| Dry do. | 18 | 35 | 22 | 16 | 16 |

See footnotes at end of table.

## TABLE 1—Continued
## MOROCCO AND WESTERN SAHARA: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

| Commodity 2/ | | 1992 | 1993 | 1994 | 1995 | 1996 e/ |
|---|---|---|---|---|---|---|
| MINERAL FUELS AND RELATED MATERIALS—Continued | | | | | | |
| Petroleum: | | | | | | |
| Crude | thousand 42-gallon barrels | 67 | 68 | 62 r/ 3/ | 36 r/ 3/ | 35 3/ |
| Refinery products: 4/ | | | | | | |
| Liquefied petroleum gas | do. | 2,920 | 3,250 | 3,300 | 3,500 e/ | 3,500 |
| Gasoline | do. | 3,460 | 3,285 | 3,300 | 3,300 e/ | 3,300 |
| Jet fuel | do. | 1,600 | 2,190 | 1,900 | 2,000 e/ | 2,000 |
| Kerosene | do. | 351 | 350 | 390 | 390 e/ | 390 |
| Distillate fuel oil | do. | 15,475 | 14,435 | 16,200 | 16,200 e/ | 16,200 |
| Residual fuel oil | do. | 14,965 | 17,150 | 17,200 | 17,300 e/ | 17,300 |
| Other | do. | 7,665 | 6,500 | 7,000 | 7,000 e/ | 7,000 |
| Total | do. | 46,436 | 47,160 | 49,290 | 49,690 e/ | 49,690 |

e/ Estimated. r/ Revised.

1/ Includes data available through Oct. 1, 1997.

2/ In addition to the commodities listed, a variety of crude construction materials are produced including possibly a substantial amount of limestone; however, information is inadequate to make reliable estimates of output levels.

3/ Reported figure.

4/ Refinery fuel and losses have been included in the output of individual products and is estimated to be about 1.8 million barrels per year.

### TABLE 2
### MOROCCO AND WESTERN SAHARA: STRUCTURE OF THE MINERAL INDUSTRY FOR 1996

(Metric tons unless otherwise specified)

| Commodity | Major operating companies and major equity owners | Location of main facilities | Annual capacity |
|---|---|---|---|
| Anthracite | Charbonnages du Maroc (CdM) (Bureau de Reherches et de Participations Minières (BRPM), 98.89%) | Jerada | 650,000. |
| Barite | Compagnie Marocaine des Barytes (COMABAR) (BRPM, 22.5%; Transocean Drilling, 55%) | Zelmou | 270,000 concentrate. |
| Cobalt | Compagnie de Tifnout Tiranimine (CTT) (BRPM, 40%; Omnium Nord Africain (ONA), 55.2%) | Bou Azzer | 150,000 ore.<br>50,000 concentrate. |
| Copper | Société Minière de Bou Gaffer (SOMIFER) (BRPM, 34.2%, ONA, 7.6%) | Bleida | 50,000 concentrate. |
| Do. | Société de Développement du Cuivre de l'Anti-Atlas (SODECAT) (BRPM, 100%) | Tiouit | 4,500 Cu, Au, Ag concentrate. |
| Fluorspar | Société Anonyme d'Entreprises Minières (SAMINE) (BRPM, 35%; ONA, 17.7%) | Meknes | 120,000 concentrate. |
| Lead | Compagnie Minière de Guemassa (CMG) (ONA, 74%; BRPM, 26%) | Hajar | 150,000 Zn concentrate.<br>32,000 Pb concentrate. |
| Do. | Compagnie Minière de Touissit (CMT) (50% Compagnie Royale Asturienne des Mines S.A., Belgium) | Touissit | 73,000 concentrate. |
| Do. | Société de Développement Industrien et Minière (BRPM, 50%) | Zeida | 40,000 concentrate. |
| Manganese | Société Anonyme Chérifienne d 'Etudes Minières (SACEM) (BRPM, 43%; COMILOG, 30%) | Quarzazate | 130,000 concentrate. |
| Petroleum refinery products thousand 42 gallon barrels | Société Marocaine de l'Industrie du Raffinage (Government, 66%; private, 34%) | Mohammedia | 45,000. |
| Do. do. | Société Chérifienne des Pétroles (SCP) (Government, 79.5%; Elf Aquitaine 24.5%) | Sidi Kacem | 9,000. |
| Phosphate million metric tons | Office Chérifien des Phosphates (OCP ) (Government, 100% ) | Khouribga, Youssoufia, Menguerir, and Bou Craa. | 25 concentrate. |
| Salt | Société de Sel de Mohammedia (SSM) ( BRPM, 100%) | Mohammedia | 150,000. |
| Do. | Société Chérifienne des Sels (SCS) (BRPM, 50%; SNSSS, 50%) | Zima | 50,000. |
| Silver | Société Metallurgique d'Imiter (SMI) (BRPM, 33%; ONA, 67%) | Near Quarzazate | 73,000 ore. |
| Steel rebar, wire rod | Société Nationale de Sidérurgie (SONASID) (Government, 65%; private, 35%) | Nador | 420,000. |

## TABLE 3
## MOROCCO: EXPORTS OF MINERAL COMMODITIES IN 1996 1/

(Metric tons unless otherwise specified)

| Commodity | Total | Destinations | |
|---|---|---|---|
| | | United States | Other (principal) |
| METALS | | | |
| Aluminum: | | | |
| Metal including alloys, all forms: | | | |
| Scrap | 2,992 | -- | France 787; Netherlands 581; Italy 505. |
| Semimanufactures | 136 | -- | France 67; Bahrain 38; Tunisia 17. |
| Cobalt: | | | |
| Ore and concentrate | 4,890 | -- | All to China. |
| Metal including alloys, all forms | 71 | 14 | Switzerland 21; Japan 20; Belgium-Luxembourg 16. |
| Copper: | | | |
| Ore and concentrate | 40,650 | -- | Spain 33,550; Poland 5,500; Belgium-Luxembourg 1,600. |
| Matte and speiss including cement copper | 1,342 | -- | All to Belgium-Luxembourg. |
| Metal including alloys, all forms: | | | |
| Scrap | 5,226 | -- | Netherlands 1,368; France 1,324; Italy 813. |
| Unwrought | 60 | -- | All to Italy. |
| Semimanufactures | 16 | (2/) | Cote d'Ivoire 8; Libya 3; Algeria 1. |
| Iron and steel: | | | |
| Iron ore and concentrate: Pyrite, roasted | 13,140 | -- | Tunisia 11,700; Belgium-Luxembourg 1,440. |
| Metal: | | | |
| Scrap | 90,590 | -- | Spain 72,667; France 11,017; Italy 5,499. |
| Semimanufactures: | | | |
| Flat-rolled products: | | | |
| Of iron or nonalloy steel: | | | |
| Not clad, plated, coated | 1,718 | -- | Senegal 664; Mali 332; Mauritania 306. |
| Clad, plated, coated | 16,227 | -- | Saudi Arabia 7,319; France 1,851; Syria 1,497. |
| Of alloy steel | 43 | -- | United Kingdom 29; Mexico 14. |
| Bars, rods, angles, shapes, sections | 58 | -- | Senegal 39; Spain 19; Ageria 1. |
| Wire | 141 | -- | Mauritania 93; Mali 37; Gabon 8. |
| Tubes, pipes, fittings value, thousands | $4,676 | -- | Libya $2,473; France $1,133; Senegal $478. |
| Lead: | | | |
| Ore and concentrate | 45,720 | -- | India 10,004; Italy 9,825; Canada 7,100. |
| Metal including alloys: | | | |
| Scrap | 243 | -- | All to Spain. |
| Unwrought | 54,522 | -- | Spain 27,607; Portugal 6,951; Tunisia 4,064. |
| Manganese: Ore and concentrate, metallurgical-grade | 29,871 | 18 | France 17,408; Spain 5,053; Italy 3,800. |
| Mercury | 19 | -- | All to India. |
| Silver: Metal including alloys, unwrought and partly wrought value, thousands | $31,602 | -- | Switzerland $13,342; France $11,503; United Kingdom $6,278. |
| Tungsten: Metal including alloys, semimanufactures do. | $1 | -- | All to Netherlands. |
| Zinc: | | | |
| Ore and concentrate | 178,175 | -- | Spain 104,225; Belgium-Luxembourg 38,200; France 21,750. |
| Metal including alloys: | | | |
| Scrap | 42 | -- | All to Italy. |
| Unwrought value, thousands | $4 | -- | France $2; Gabon $1. |
| Other: | | | |
| Ores and concentrates | 258,655 | 18 | Spain 109,428; Belgium-Luxembourg 44,274; France 40,489. |
| Oxides and hydroxides | 1 | -- | All to France. |
| Ashes and residues | 1,123 | -- | South Africa 486; Belgium-Luxembourg 328; India 204. |
| INDUSTRIAL MINERALS | | | |
| Abrasives, n.e.s.: | | | |
| Natural: Corundum, emery, pumice, etc. | 11 | -- | Egypt 5; United Arab Emirates 3; Saudi Arabia 2. |
| Grinding and polishing wheels and stones | 3 | -- | France 1; Mali 1. |
| Barite and witherite | 321,520 | 57,000 | Norway 127,885; United Kingdom 66,352; Congo 12,560. |
| Cement | 244,027 | -- | Spain 128,828; Mauritania 32,730; Brazil 30,000. |
| Chalk | 42 | -- | Mauritania 29; Congo 13. |
| Clays, crude: | | | |
| Bentonite | 20,090 | -- | Germany 13,552; Denmark 4,405; France 2,120. |
| Unspecified | 26,785 | -- | Italy 17,600; United Kingdom 3,900; Spain 3,055. |

See footnotes at end of table.

## TABLE 3--Continued
## MOROCCO: EXPORTS OF MINERAL COMMODITIES IN 1996 1/

(Metric tons unless otherwise specified)

| | | Destinations | |
|---|---|---|---|
| Commodity | Total | United States | Other (principal) |
| INDUSTRIAL MINERALS--Continued | | | |
| Fertilizer materials: | | | |
| Phosphatic thousand tons | 1,750 | 26 | France 223; Pakistan 220; Italy 195. |
| Unspecified and mixed | 134,926 | -- | Spain 58,388; Italy 31,207; France 23,690. |
| Fluorspar | 94,014 | -- | Canada 41,850; Norway 31,955; Tunisia 14,988. |
| Gypsum and plaster | 231,407 | 17 | Senegal 40,712; Cote d'Ivoire 40,162; United Kingdom 26,800. |
| Lime | 121 | -- | Cote d'Ivoire 98; Saudi Arabia 10; Spain 8. |
| Mica: Worked including agglomerated splittings | 1 | -- | All to Italy. |
| Phosphates, crude thousand tons | 10,140 | 1,733 | Spain 1,798; Mexico 1,739; Poland 675. |
| Pigments, mineral: Iron oxides and hydroxides, processed | 1 | -- | All to Mauritania. |
| Precious and semiprecious stones other than diamond, natural value, thousands | $1 | -- | All to France. |
| Salt and brine | 68,250 | -- | United Kingdom 49,050; Denmark 16,750; Sweden 2,450. |
| Stone, sand and gravel: | | | |
| Dimension stone: | | | |
| Crude and partly worked | 14,119 | 1 | Spain 8,781; Italy 5,087; South Africa 123. |
| Worked | 734 | 163 | Italy 196; Germany 94; Spain 83. |
| Gravel and crushed rock | 239,272 | -- | Spain 239,264. |
| Sand other than metal-bearing | 383,787 | -- | All to Spain. |
| Sulfur: Elemental: Crude including native and byproduct | 23 | -- | Egypt 11; Libya 7; Algeria 5. |
| Talc, steatite, soapstone, pyrophyllite | 9 | -- | Libya 5; Tunisia 4. |
| MINERAL FUELS AND RELATED MATERIALS | | | |
| Carbon black | 6 | -- | All to Mauritania. |
| Peat including briquets and litter | 50 | -- | All to Libya. |
| Petroleum refinery products: | | | |
| Gasoline | 268,971 | -- | Netherlands 146,258; Cote d'Ivoire 29,929; Ghana 22,000. |
| Distillate fuel oil | 22,059 | -- | Mainly for bunkers. |
| Lubricants | 73,351 | -- | Tunisia 32,251; Netherlands 29,000; Nigeria 7,600. |
| Bituminous mixtures | 21 | -- | All to Guinea. |

1/ Table prepared by Glenn J. Wallace.

2/ Less than 1/2 unit.

Source: United Nations Statistical Office (microfiche).

## TABLE 4
## MOROCCO: IMPORTS OF MINERAL COMMODITIES IN 1996 1/

(Metric tons unless otherwise specified)

| | | | Sources | |
|---|---|---|---|---|
| Commodity | | Total | United States | Other (principal) |
| METALS | | | | |
| Akali and akaline-earth metals: | | | | |
| Alkali metals | value, thousands | $1 | -- | All from France. |
| Alkaline-earth metals | | 3 | -- | Belgium-Luxembourg 2; Austria 1. |
| Aluminum: | | | | |
| Ore and concentrate | | 19,944 | -- | Italy 18,750; China 642; Guyana 552. |
| Oxides and hydroxides | | 5,613 | 16 | France 3,324; Germany 1,871; Spain 116. |
| Metal including alloys, all forms: | | | | |
| Unwrought | | 1,599 | -- | Netherlands 772; Norway 597; Germany 108. |
| Semimanufactures | | 14,171 | 11 | Canada 3,203; France 3,099; Spain 1,587. |
| Antimony: Metal including alloys, all forms | | 9 | -- | Mainly from China. |
| Bismuth: Metal including alloys, all forms | value, thousands | $2 | -- | All from France. |
| Chromium: | | | | |
| Ore and concentrate | | 33 | -- | Spain 21; Belgium-Luxembourg 12. |
| Oxides and hydroxides | | 25 | 5 | France 14; Italy 5; Canada 1. |
| Cobalt: | | | | |
| Oxides and hydroxides | | 1 | -- | Mainly from France. |
| Metal including alloys, all forms | value, thousands | $36 | $3 | Germany $27; France $6. |
| Columbium and tantalum: Tantalum metal including alloys, all forms | do. | $3 | -- | All from Spain. |
| Copper: | | | | |
| Matte and speiss including cement copper | | 10 | -- | Mainly from Italy. |
| Metal including alloys, all forms: | | | | |
| Scrap | | 31 | -- | Italy 16; Spain 11; France 5. |
| Unwrought | value, thousands | $1,290 | $13 | France $787; Spain $270; Italy $218. |
| Semimanufactures | | 17,898 | 10 | France 8,023; Belgium-Luxembourg 5,050; Germany 1,116. |
| Gold: Metal including alloys, unwrought and partly wrought | value, thousands | $3 | $3 | |
| Iron and steel: | | | | |
| Iron ore and concentrate: Pyrite, roasted | | 2,916 | -- | Canada 2,905; Portugal 11. |
| Metal: | | | | |
| Scrap | | 1,525 | -- | Switzerland 1,001; Belgium-Luxembourg 500; France 24. |
| Pig iron, cast iron, related materials | | 3,542 | -- | Romania 782; Germany 519; Spain 515. |
| Ferroalloys: | | | | |
| Ferrochromium | | 35 | -- | Belgium-Luxembourg 23; Norway 5; Russia 5. |
| Ferromanganese | | 135 | -- | Belgium-Luxembourg 66; Spain 29; China 20. |
| Ferrosilicomanganese | | 49 | -- | France 26; Belgium-Luxembourg 15; Norway 8. |
| Ferrosilicon | | 116 | -- | Norway 40; Spain 35; Belgium-Luxembourg 29. |
| Silicon metal | | 11 | -- | Germany 9; France 2. |
| Unspecified | | 4 | -- | Belgium-Luxembourg 3; China 1. |
| Steel, primary forms | | 523,065 | -- | Italy 114,761; Portugal 92,286; Poland 74,251. |
| Semimanufactures: | | | | |
| Flat-rolled products: | | | | |
| Of iron or nonalloy steel: | | | | |
| Not clad, plated, coated | | 169,472 | 1,797 | Libya 31,170; Germany 23,781; Argentina 19,472. |
| Clad, plated, coated | | 49,456 | 144 | France 16,715; Germany 10,928; Brazil 8,717. |
| Of alloy steel | | 7,267 | -- | France 3,805; Spain 1,300; Belgium-Luxembourg 714. |
| Bars, rods, angles, shapes, sections | | 161,240 | -- | Spain 57,458; Turkey 26,832; Italy 17,609. |
| Rails and accessories | | 1,006 | (2/) | France 592; Spain 400; Italy 13. |
| Wire | | 13,326 | (2/) | Belgium-Luxembourg 3,868; Spain 2,632; France 1,712. |
| Tubes, pipes, fittings | | 14,940 | 642 | France 3,618; Spain 2,350; Czech Republic 1,724. |
| Lead: | | | | |
| Ore and concentrate | | 29,475 | -- | Spain 7,322; Italy 5,687; Peru 5,338. |
| Oxides | | 464 | -- | Spain 298; Italy 96; Germany 65. |
| Metal including alloys: | | | | |
| Unwrought | | 133 | -- | France 89; Sweden 18; Belgium-Luxembourg 17. |
| Semimanufactures | | 66 | -- | Netherlands 18; France 14; Belgium-Luxembourg 12. |

See footnotes at end of table.

## TABLE 4--Continued
## MOROCCO: IMPORTS OF MINERAL COMMODITIES IN 1996 1/

(Metric tons unless otherwise specified)

| Commodity | Total | Sources | |
|---|---|---|---|
| | | United States | Other (principal) |
| METALS--Continued | | | |
| Magnesium, metal including alloys: | | | |
| Unwrought | 4 | -- | Mainly from United Kingdom. |
| Semimanufactures | 14 | 4 | Do. |
| Manganese: | | | |
| Ore and concentrate, metallurgical-grade | 6 | -- | All from Spain. |
| Oxides | 1,187 | -- | Japan 1,180; Belgium-Luxembourg 7; Italy 1. |
| Mercury value, thousands | $8 | -- | France $3; Sweden $3; Hong Kong $1. |
| Molybdenum: Metal including alloys, semimanufactures do. | $1 | -- | All from France. |
| Nickel: | | | |
| Matte and speiss | 4 | -- | Belgium-Luxembourg 2; United Kingdom 2. |
| Metal including alloys: | | | |
| Unwrought | 44 | (2/) | France 21; Canada 17; Italy 3. |
| Semimanufactures | 20 | -- | Germany 10; United Kingdom 7; France 2. |
| Platinum-group metals including alloys, unwrought and partly wrought value, thousands | $22 | -- | Belgium-Luxembourg $17; France $5. |
| Silver: Metal including alloys, unwrought and partly wrought do. | $184 | -- | France $120; Italy $52; Netherlands $9. |
| Tin: | | | |
| Ore and concentrate | 3 | -- | All from Belgium-Luxembourg. |
| Metal including alloys: | | | |
| Scrap | 1 | -- | All from France. |
| Unwrought | 142 | -- | China 33; Malaysia 31; Netherlands 30. |
| Semimanufactures | 7 | -- | Netherlands 5; Malaysia 1; Spain 1. |
| Titanium: | | | |
| Ore and concentrate | 174 | -- | South Africa 122; Spain 32; Germany 20. |
| Oxides | 476 | 20 | France 188; Germany 161; Saudi Arabia 80. |
| Metal including alloys, semimanufactures value, thousands | $46 | -- | France $32; Belgium-Luxembourg $7; Germany $5. |
| Tungsten: | | | |
| Ore and concentrate | 1 | -- | All from France. |
| Metal including alloys: | | | |
| Scrap and unwrought value, thousands | $2 | -- | Do. |
| Semimanufactures | 1 | -- | Mainly from France. |
| Zinc: | | | |
| Oxides | 254 | -- | France 103; Netherlands 54; Portugal 42. |
| Blue powder | 162 | -- | France 99; Belgium-Luxembourg 58. |
| Metal including alloys: | | | |
| Unwrought | 6,313 | 25 | Algeria 3,011; Belgium-Luxembourg 1,247; Russia 1,038. |
| Semimanufactures | 327 | -- | Belgium-Luxembourg 252; Italy 44; Germany 23. |
| Zirconium: | | | |
| Ore and concentrate | 81 | -- | South Africa 41; Italy 40. |
| Metal including alloys, semimanufactures | 1 | -- | All from Canada. |
| Other: | | | |
| Ores and concentrates | 5,706 | -- | Italy 5,700; France 6. |
| Oxides and hydroxides | 67 | -- | Norway 25; United Kingdom 10; France 9. |
| INDUSTRIAL MINERALS | | | |
| Abrasives, n.e.s.: | | | |
| Natural: Corundum, emery, pumice, etc. | 7,191 | 6 | Turkey 6,131; Greece 711; Spain 156. |
| Artificial, corundum | 599 | -- | France 165; Germany 139; Hungary 114. |
| Dust and powder of precious and semiprecious stones including diamond value, thousands | $7 | -- | All from Switzerland. |
| Grinding and polishing wheels and stones | 842 | (2/) | Italy 587; France 79; Denmark 62. |
| Asbestos, crude | 5,644 | -- | Canada 4,107; Mozambique 703; Switzerland 537. |
| Barite and witherite | 203 | -- | Germany 159; Spain 43. |
| Boron materials: Oxides and acids | 31 | 4 | France 24; Canada 1; Germany 1. |
| Bromine, fluorine, iodine value, thousands | $16 | -- | France $10; Chile $3; Germany $1. |
| Cement | 61,986 | -- | Spain 23,543; Turkey 14,755; France 13,536. |
| Chalk | 7,910 | -- | Spain 4,121; France 3,723; Switzerland 66. |

See footnotes at end of table.

TABLE 4--Continued

MOROCCO: IMPORTS OF MINERAL COMMODITIES IN 1996 1/

(Metric tons unless otherwise specified)

| Commodity | | Total | Sources | |
|---|---|---|---|---|
| | | | United States | Other (principal) |
| INDUSTRIAL MINERALS--Continued | | | | |
| Clays, crude: | | | | |
| Bentonite | | 92 | -- | Spain 48; Greece 20; Portugal 20. |
| Kaolin | | 14,666 | 74 | United Kingdom 7,928; Spain 4,445; France 1,318. |
| Unspecified | | 16,951 | 1 | France 7,762; Ukraine 6,000; United Kingdom 2,107. |
| Diamond, natural: | | | | |
| Gem, not set or strung | value, thousands | $120 | -- | Thailand $69; Belgium-Luxembourg $35; United Kingdom $10. |
| Industrial stones | do. | $9 | -- | All from Switzerland. |
| Diatomite and other infusorial earth | | 985 | 1 | Algeria 360; Spain 301; France 262. |
| Feldspar | | 4,528 | -- | Spain 3,825; France 501; Norway 64. |
| Fertilizer materials: | | | | |
| Crude, n.e.s. | | 611 | -- | Spain 523; France 56; Netherlands 23. |
| Manufactured: | | | | |
| Ammonia | | 333,856 | 29,676 | Russia 226,173; Ukraine 47,621; Saudi Arabia 20,010. |
| Nitrogenous | | 488,598 | 3,503 | Russia 155,359; Belgium-Luxembourg 78,392; Romania 54,356. |
| Phosphatic | value, thousands | $6 | -- | All from Italy. |
| Potassic | | 88,843 | -- | Germany 44,207; Ukraine 18,210; Belgium-Luxembourg 5,875. |
| Unspecified and mixed | | 4,108 | 178 | France 1,778; Spain 694; Belgium-Luxembourg 380. |
| Graphite, natural | | 72 | -- | France 49; Spain 23. |
| Gypsum and plaster | | 1,448 | 3 | Spain 938; France 454; United Kingdom 23. |
| Lime | | 124 | -- | Spain 97; France 27. |
| Magnesium compounds: | | | | |
| Magnesite, crude | | 46 | -- | Austria 40; Italy 5. |
| Oxides and hydroxides | | 290 | 20 | Spain 196; Netherlands 31; United Kingdom 20. |
| Mica: | | | | |
| Crude including splittings and waste | | 5 | -- | Germany 2; Norway 2; France 1. |
| Worked including agglomerated splittings | | 2 | (2/) | France 1; Spain 1. |
| Nitrates, crude | | 391 | -- | Chile 386; Germany 5. |
| Phosphates, crude | value, thousands | $3 | -- | Switzerland $2; France $1. |
| Pigments, mineral: Iron oxides and hydroxides, processed | | 1,548 | 10 | Germany 532; United Kingdom 519; China 190. |
| Precious and semiprecious stones other than diamond: | | | | |
| Natural | value, thousands | $27 | -- | Thailand $21; Germany $5; France $1. |
| Synthetic | do. | $116 | -- | Thailand $41; France $36; Italy $30. |
| Pyrite, unroasted | | 148 | -- | France 132; Germany 10; Spain 3. |
| Salt and brine | | 779 | 19 | United Kingdom 640; Netherlands 82; France 21. |
| Sodium compounds, n.e.s.: | | | | |
| Soda ash, manufactured | | 22,841 | -- | Spain 16,341; Portugal 3,190; Italy 2,500. |
| Sulfate, manufactured | | 16,866 | -- | Spain 16,784; Germany 57; Libya 13. |
| Stone, sand and gravel: | | | | |
| Dimension stone: | | | | |
| Crude and partly worked | | 9,482 | -- | Italy 8,371; Spain 852; Portugal 172. |
| Worked | | 6,981 | 3 | Italy 4,044; Spain 2,521; Greece 244. |
| Dolomite, chiefly refractory-grade | | 1,060 | -- | Spain 631; France 424; Norway 5. |
| Gravel and crushed rock | | 722 | -- | Spain 363; France 297; Belgium-Luxembourg 61. |
| Quartz and quartzite | | 1,708 | -- | Spain 882; Belgium-Luxembourg 766; Italy 35. |
| Sand other than metal-bearing | | 47,797 | 19 | Belgium-Luxembourg 45,309; Portugal 1,500; Spain 454. |
| Sulfur: | | | | |
| Elemental: | | | | |
| Crude including native and byproduct | thousand tons | 2,601 | -- | Canada 1,010; Saudi Arabia 770; Poland 473. |
| Colloidal, precipitated, sublimed | value, thousands | $19 | -- | All from France. |
| Dioxide | | 72 | -- | Do. |
| Sulfuric acid | | 33,026 | -- | Spain 21,235; Sweden 6,208; Italy 4,199. |
| Talc, steatite, soapstone, pyrophyllite | | 2,284 | -- | France 1,378; Spain 428; Finland 315. |
| Vermiculite, perlite, chlorite | | 14 | -- | Spain 12; France 2. |

See footnotes at end of table.

TABLE 4--Continued

MOROCCO: IMPORTS OF MINERAL COMMODITIES IN 1996 1/

(Metric tons unless otherwise specified)

| | | | Sources | |
|---|---|---|---|---|
| Commodity | | Total | United States | Other (principal) |
| MINERAL FUELS AND RELATED MATERIALS | | | | |
| Asphalt and bitumen, natural | | 303 | -- | United Kingdom 300; France 3. |
| Carbon black | | 7,954 | 3 | Egypt 2,772; Portugal 1,990; Italy 984. |
| Coal: | | | | |
| Anthracite | | 23,174 | -- | South Africa 20,792; United Kingdom 2,382. |
| Other | thousand tons | 2,186 | 1,548 | South Africa 637. |
| Coke and semicoke | | 32,700 | -- | China 12,979; Italy 8,972; Spain 8,700. |
| Gas, natural, gaseous | value, thousands | $9 | -- | All from Spain. |
| Peat including briquets and litter | | 13,680 | -- | Germany 12,983; France 307; Denmark 265. |
| Petroleum: | | | | |
| Crude | thousand tons | 5,743 | -- | Saudi Arabia 2,788; Nigeria 1,206; Libya 698. |
| Refinery products: | | | | |
| Liquefied petroleum gas | | 687,899 | -- | Algeria 267,158; France 191,665; Spain 78,995. |
| Gasoline | | 76,620 | 181 | Spain 69,725; Portugal 4,067; France 1,516. |
| Mineral jelly and wax | | 13,043 | 136 | Hungary 4,489; Spain 4,050; Germany 1,617. |
| Kerosene and jet fuel | | 14 | -- | All from Belgium-Luxembourg. |
| Distillate fuel oil | | 432,856 | -- | Spain 309,044; Libya 96,131; Portugal 10,300. |
| Lubricants | | 5,814 | 356 | Libya 4,019; Netherlands 475; Belgium-Luxembourg 348. |
| Bitumen and other residues | | 58 | -- | United Kingdom 56; France 2. |
| Bituminous mixtures | | 119 | -- | Spain 66; France 39; Italy 14. |
| Petroleum coke | | 617,616 | 560,726 | Netherlands Antilles 29,180; Venezuela 27,705. |

1/ Table prepared by Glenn J. Wallace.

2/ Less than 1/2 unit.

Source: United Nations Statistical Office (microfiche).

### THE MINERAL INDUSTRY OF

# MOZAMBIQUE

### By George J. Coakley

Following nearly 30 years of fighting both prior to gaining independence from Portugal in 1974 and subsequently to resolve a prolonged internal civil war, 1994 finally brought peace and a freely elected government to Mozambique. Efforts since then to rebuild the economy have placed a major emphasis on mineral-resource development and regional economic integration. Development plans to date depend heavily on the energy potential of the underutilized Cabora Bassa hydroelectric dam; the Pande, Temane, and Buzi natural gas fields; and the country's coal resources at Moatize; along with modernization of the Indian Ocean export harbors at Beira, Maputo-Matola, and Nacala.

Official exports were dominated by bauxite, gemstones, gold, and marble. In addition to active exploration for gold and gemstones and the recent opening of new gold and graphite mines and a renovated marble mine, several major, large scale projects were in various stages of development planning. Billiton Plc's South African subsidiary, Alusaf, Ltd. in partnership with the Industrial Development Corp. (IDC) of South Africa has proposed to form Mozambique Aluminum Co., to be referred to as Mozal, to develop a $1.1 billion, 245,000-metric-ton-per-year (t/yr) aluminum smelter 17 kilometers west of Maputo by 2000. JCI Ltd. of South Africa and Companhia Vale do Rio Doce of Brazil are planning a $2 billion investment to develop 2.2 billion tons of coking coal at Moatize and an associated export facility. Enron Development Corp. of the United States plans to invest at least $1 billion to develop the estimated 3 trillion cubic feet of reserves in the Pande gasfield and associated pipelines needed to feed other industrial projects. JCI Ltd. is looking at developing a $0.55 billion, 2.6-million-metric-tons-per-year (Mt/yr), hot briquetted iron ore plant near the port of Beira, using iron ore from Brazil and Zimbabwe and Pande gas. IDC is examining the feasibility of combining Pande gas with stockpiled byproduct magnetite ore from the Palabora Copper Mine in South Africa to build a $1-billion, 4-Mt/yr direct-reduced-iron plant near Maputo. An adjacent 3.4-Mt/yr slab steel plant is also being considered. In titanium developments, Gencor Ltd. of South Africa's Genbique subsidiary is planning to develop the Moebase/Tigen mineral sands project at a cost of $450 million by 1999-2000; and BHP International Minerals of Australia and Kenmare Resources Plc. of Ireland planned to invest $300 million to develop the Congolone titaniferous sands concession near Angoche. The Congolone project would produce 35,000 t/yr zircon, 418,000 t/yr ilmenite, and 8,000 t/yr rutile by 2000. Additional substantial investment is being made to upgrade or develop road, railroad, port capacity, and hydroelectric power infrastructure.

**Major Sources of Information**

Ministry of Mineral Resources and Energy
Avenida Fernao Magalhaes 34
Maputo, Mozambique
Telephone: 258-1-429615
Fax: 258-1-429541
National Directorate of Mines
Praca 25 de Junho
Maputo, Mozambique
Telephone: 258-1-427121
Fax: 258-1-429046
National Directorate of Geology
Praca 25 de Junho
Maputo, Mozambique
Telephone: 258-1-424031
Fax: 258-1-429046
Empresa Nacional de Hidrocarbonetos (ENH)
Avenida Fernao Magalhaes 34
Maputo, Mozambique
Telephone: 258-1-427634
Fax: 258-1-430931
National Energy Directorate
Avenida 25 de Setembro 1218
Maputo, Mozambique
Telephone: 258-1-420147
Fax: 258-1-420245

## TABLE 1
## MOZAMBIQUE: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

| Commodity 2/ | | 1992 | 1993 | 1994 | 1995 e/ | 1996 e/ |
|---|---|---|---|---|---|---|
| Bauxite | | 8,340 | 6,000 | 9,620 | 10,700 | 10,700 |
| Cement, hydraulic e/ | thousand tons | 30 | 20 | 20 | 30 | 30 |
| Clays, bentonite | | 20 | 100 e/ | 3,350 | 3,500 | 3,500 |
| Coal, bituminous | | 48,000 | 48,400 | 58,190 | 60,610 | 60,600 |
| Copper: Concentrate: | | | | | | |
| Gross weight | | -- | -- | 1,240 | -- | -- |
| Cu content e/ | | -- | -- | 259 | -- | -- |
| Gemstones: Semiprecious: | | | | | | |
| Cut stones, all types | carats | 8,450 | 7,690 | 6,450 | 6,000 | 6,000 |
| Rough stones e/ 3/ | kilograms | 750 | 560 | 7,000 | 8,000 | 8,000 |
| Gold 4/ | do. | 296 | 149 | 6,804 r/ | 6,800 r/ | 6,800 |
| Graphite, concentrates | | -- | 10 | 430 | 4,000 r/ | 5,000 |
| Marble: | | | | | | |
| Block | cubic meters | 919 | 1,380 | 1,500 | 1,500 | 1,500 |
| Slab | square meters | -- | 34 | 52,300 | 52,300 | 52,300 |
| Salt, marine e/ | | 30,000 | 35,000 | 40,000 | 40,000 | 40,000 |

e/ Estimated. r/ Revised.

1/ Data available through March 10, 1998.

2/ In addition to the commodities listed, modest quantities of unlisted varieties of crude construction materials (other clays, sand and gravel, and stone) presumably are produced, as is a small amount of natural gas. For these commodities, output is not reported quantitatively and information is insufficient to make reliable estimates.

3/ Artisanal production of rough gemstones include in order of importance: tourmaline, garnet, dumortierite, aquamarine, emerald, and morganite.

4/ Does not include artisanal gold, for which there were no data, but which the Government has estimated at about 4,000 kilograms per year.

## THE MINERAL INDUSTRY OF

# NAMIBIA

### By George J. Coakley

The mineral industry of Namibia provided about 11% of the country's $3.2 billion[1] gross domestic product in 1996 and annually contributes to approximately 50% of the value of total exports earnings. The industry is dominated by three established mining companies namely: Namdeb Diamond Corp. (Pty.) Ltd., Rossing Uranium Ltd., and Tsumeb Corp. Ltd., with the Government's proactive policies encouraging new entrants in copper, diamonds, natural gas, and zinc.

Encouraged by a favorable investment environment and the supporting technical resource assessment work of the Geological Survey of Namibia, over 60 companies were actively exploring in 1996 (Mining Journal, 1997). A number of Australian and Canadian companies, predominately exploring for diamonds and gold, augmented local prospecting activities. During the year, 488 nonexclusive prospecting licenses, 53 exclusive prospecting licenses, and 2 mining licenses were issued by the Government. The Chamber of Mines membership reported exploration expenditures of over $25 million in 1996. Marine diamond exploration was maintained in high gear with Namibian Minerals Corp. (Namco) and Ocean Diamond Mining Holdings (ODM) most active and expected to move into production in 1997. The often acerbic relationship, which was developed between land owners, prospecting companies, and individuals was finally legally addressed in 1996 by the formation of the Minerals Ancillary Commission which produced several successful solutions on a number of issues.

## Government Policies and Programs

The basic mining law is the Minerals (Prospecting and Mining ) Act, No. 33 of 1992, which took effect on April 1, 1994. It provided for a standard licensing regime with special provisions to promote investment by foreign and domestic enterprises in minerals exploration and extraction. An accompanying Mining (Taxation) Act set forth revised fiscal provisions for the industry. The main innovation was a provision for royalty payments by producers to the Government. The Chamber of Mines of Namibia outlined the mining tax environment in a late 1995 promotional publication (Chamber of Mines of Namibia, 1995).

With regard to mining activities, excluding petroleum and diamond mines, the Minerals Act allows all exploration expenditures incurred before the startup of mining to be written off in the first year of production and subsequent exploration expenditures in the year incurred. In the case of development expenditures, however, the new act stipulated that only one-third could be written off in the year incurred and one-third in each of the two ensuing years. The new progressive tax rates applicable to nondiamond and nonpetroleum mining companies vary from 25% to 55%, with most companies' rates ranging from 25% to 40%.

The system of taxation on diamond mining consisted of three separate taxes: income, diamond profits, and diamond export duties. The latter has now been replaced by a 10% royalty. The overall income tax on diamond mining companies is levied at the rate of 55% of taxable income, plus a surcharge of 10% on the market value of diamonds shipped and sold. The Income Tax Act provides that this 10% surcharge paid as diamond profits tax be credited against the income tax payable by diamond mines.

The fiscal regime for oil exploration companies consists of three principal elements: an income tax and an Additional Profits Tax (APT), both levied in terms of the Petroleum (Taxation) Act, No. 3 of 1991; and a royalty, levied in terms of the Petroleum (Exploration and Production) Act, No. 2 of 1991. With respect to the income tax, the applicable tax rate is 42% of taxable income. The APT is a tax on profits above a level necessary to earn a reasonable rate of return on investment. A three-tiered incremental APT scheme is provided in this legislation. The first-tier APT rate is at 25% when the net rate of return reaches 15%. The second- and third-tier incremental APT rates are negotiated between the Government and the oil company. As in the case of the petroleum income tax, the APT is applied on a license or contract area basis. This means that expenditures incurred on different oilfields within the same license can be deducted from the revenues generated not only by a particular oilfield but from any and all others in the license area, thereby reducing the negative financial impact of any unsuccessful drilling programs. The Petroleum (Exploration and Production) Act, No. 2 of 1991, provides that the holder of a production license for petroleum is required to pay to the State Revenue Fund a royalty of 12.5% of the market value of petroleum produced. However, the act provides that the Minister of Mines and Energy may, in concurrence with the Minister of Finance, remit wholly or partly any payable royalty, or defer payment of any such royalty with the intention to assist any marginal oilfield development.

The Foreign Investment Act of 1990 offers prospective investors a package of incentives, such as repatriation of profits, security of title and tenure, availability of foreign exchange, international arbitration, and fair compensation in case of expropriation.

The Ministry of Mines and Energy is responsible for making and enforcing policies related to minerals and energy. Within the ministry and attached to the Permanent Secretary are the Diamond Board, the Mining Advisory Board, and the National Energy Council, all of which have Government and private-sector representation. The Namibia Petroleum Co. and the Namibia Electricity Development Co. also are part of the ministry. The four main directorates in the ministry are the Geological Survey, Mining, Energy, and Administration and Finance. The three main functions of the Mining Directorate are evaluating and controlling mineral license applications; ensuring adequate safety standards in mining operations; and collecting, analyzing, and disseminating production statistics. An Ancillary Rights Commisssion was set up by the Ministry to handle dispute arbitration.

---

[1] Where necessary, values have been converted from the Namibian dollar (ND) to U.S. dollars at the rate of N$4.6=US$1.00 for 1996 and N$3.63=US$1.00 for 1995.

The Government also is empowered to review exploration licenses issued under the previous mining law to determine if the holders of the licenses are actually conducting exploration activities. If the Government determines that insufficient work is being done, it can revoke the license and make an award to someone else. That review was expected to free up considerable land area for exploration, previously locked up by the practice of "ringfencing" of claims.

## Environmental Issues

As one of the major sectors of the economy, the mining industry plays an active role in funding conservation awareness and environmental education programs. Some of Namibia's mines are located in or close to one of the world's oldest deserts, the Namib, which is host to a number of extremely rare species of plant and animal life. This unique habitat is one of Namibia's most valuable tourist assets and the ecosystem are closely monitored by the local and international scientific and conservation communities. The competition for limited water resources between human and industrial use will remain an ongoing environmental concern for the country.

In addition to the desert, Namibia possesses several "wetland" areas of international repute, particularly the Etosha Salt Pan, the Okavango/Caprivi region, and in the vicinity of the Walvis Bay lagoon and Sandwich Harbor and the Orange River environs. The fragile nature of these desert and wetland ecosystems must be taken into account during the consideration of any infrastructure projects such as resource trade oriented railroads or pipelines between Walvis Bay and northeast Namibia and Botswana. Comprehensive studies have been undertaken to assess the effects of marine mining operations with respect to these areas and, in particular, the changes in tidal patterns caused by the disposal of offshore fines. In addition, work is being carried out to assess the extent of any interaction between marine mining activities and the local fishing (mainly lobster) and mariculture (oyster and mussel production) industries and to provide information which will assist these industries to develop and coexist with minimal adverse effects upon each other.

## Production and Trade

The production statistics in table 1 were compiled mostly from the Namibia Ministry of Mines and Energy response to the U.S. Geological Survey's annual minerals questionnaire and from Chamber of Mines and company reports. Production of mineral commodities generally declined in Namibia in 1996, compared with 1995 output. Gold, diamond, uranium, and zinc production showed slight improvement, while declines in copper mine and copper and lead smelter production were attributed to strike activity at Tsumeb. Lithium minerals and semiprecious stones were generally lower in 1996.

The latest available trade data showed that ores and minerals accounted for 51.2% of the value of total exports of $1.43 billion in 1995, compared to 49.4% of the value of total exports of $1.34 billion in 1994 (Africa Trade and Business Bulletin, 1998). Diamond was the major mineral export valued at $485 million in 1995, followed by gold at $70 million, combined lead-zinc-silver exports at $36 million and all others, including uranium, valued at $113 million. Available breakouts on 1994 total imports of $1.4 billion showed that mineral fuels and lubricants accounted for $144 million and metals and metal products, $72 million.

In general, relations between the Mineworkers Union of Namibia (MUN) and the various corporate members of the Chamber of Mines were cordial with annual wage negotiations conducted in an expeditious manner. Various agreements between the MUN and Chamber members were signed, including an Occupational Health and Safety agreement, and in the case of Namdeb, a Localization and Succession Planning Agreement. The most important dispute occurred between the MUN and Tsumeb Corp. Ltd., resulting in a strike action from August 22 to October 5. Finally, the intervention of the Prime Minister's office resolved the dispute.

The Chamber of Mines during 1996, consists of 56 company representatives, compared with 47 members in 1995. The majority of mining companies in Namibia were owned privately, whereas Government participation in mining remained limited as shown in table 2.

## Commodity Review

### *Metals*

**Antimony.**—The Tsumeb smelter plant reported production of 16 tons of sodium antimonate, containing approximately 47% antimony.

**Copper.**—A major strike action against the Tsumeb Corp. Ltd. late in 1996 contributed to declines of more than 30% in copper mine and smelter production compared with 1995. The 6-week strike action by MUN, fought over wage increases, was settled in early October when MUN agreed to a 10.5% wage increase (Mining Journal, 1996b). Flooding of the mines and the seizing up of the smelter during the strike closure led to over $5 million in damages that was subsequently recovered by insurance (Metal Bulletin, 1996b; U.S. Embassy, Windhoek, Namibia, 1996). After 95 years of continuous mining, the world famous Tsumeb Mine ceased copper production in 1996. During its lifetime, the mine produced 29 million metric tons (Mt) of ore grading about 5% copper, 15% lead, 150 grams per ton silver, and up to 2% zinc (Mining Journal, 1997). During the year the company also opened its new, small, high grade, Khusib copper-silver-lead mine to supplement Kombat and Ojithase copper concentrate feed to the reopened Tsumeb copper smelter. Commissioning of a new tailings retreatment project was also delayed by the strike.

In other copper developments, Namibia-Australian Exploration (Namaust) announced plans to establish a small open pit mine at its newly discovered copper deposit near Kobos, 50 kilometers (km) southwest of Rehoboth. Namaust reported resources of 138,000 metric tons (t) grading 1.1% copper. The Australian firm, Great Fitzroy Mines (20%) and their American joint-venture partner, Namibia Copper Mines (80%) began a bankable feasibility study, to be completed by January 1997, aimed at bringing the Haib porphyry copper deposit into production by mid-1998. The Haib deposit has a reported minable resource of 300 Mt of 0.41% copper and a lower grade resource of nearly 1 billion tons averaging 0.19% copper. Project costs are estimated at $600 million to develop the mine and associated solvent extraction/electrowinning facilities. Annual production capacity is expected to be 85,000 t of copper, 311 kilograms of gold and 357 t of molybdenum (Metal Bulletin, 1996a; Mining Journal, 1996a).

**Gold.**—In 1996, gold production decreased by some 16% from 1995. Erongo Mining and Exploration Co. Ltd.'s Navachab gold mine produced 1,863 kg, accounting for 87% of the national total during 1996. The ore treatment plant at Navachab was to be upgraded during 1997 to increase throughput to 1.3 million metric tons per year (Mt/yr).

**Lead and Zinc.**— In 1996, lead and zinc was produced by two companies, Tsumeb and the reconstituted owners of the Rosh Pinah Mine, Imcor Tin (Pty.) Ltd. Tsumeb produced 26,636 t of lead concentrates and 8,588 t of refined lead. The commissioning of the new 30,000 metric tons per year (t/yr) Ausmelt smelter was delayed by the industrial strike action at Tsumeb in 1996 and was scheduled to commence operation in early 1997. The environmentally cleaner Ausmelt technology from Australia will replace Tsumeb's sinter plant and blast furnace technology.

Rosh Pinah mine/mill output included 69,689 t of zinc concentrate containing 35,873 t of zinc metal and 28,211 t of lead concentrates containing 12,416 t of lead metal and 12.4 t of silver. Rosh Pinah went through a major corporate restructuring during 1996 with Iscor Ltd. of South Africa buying out the minority partner Moly Copper Mining and Exploration Co. of Namibia and shifting the operating company from its subsidiary, Imcor Zinc (Pty.) Ltd. to Imcor Tin (Pty.) Ltd. Iscor then sold a 100% interest in Imcor Tin to the Australian company Western Metals Ltd. Minority shares in Western Metals are held by Iscor (27%) and Padaeng Industry of Thailand (20%). Western Metals was examining the potential to expand capacity at Rosh Pinah from 600,000 t/yr of ore to 1 Mt/yr for an investment of $30 million (Mining Journal, 1996c; Iscor Ltd., 1996).

In a potentially major sectoral development, Reunion Mining of the United Kingdom, acquired an option to earn a 60% interest in the Scorpion zinc deposit, 20 km north of the Rosh Pinah Mine, from the Anglo American subsidiary, Erongo Mining and Exploration Co. Ltd. by spending at least $1 million and committing to develop a mine. Resources are estimated at 8.3 Mt grading 10.9% zinc. Prefeasibility studies suggested that the ore was amenable to sulfuric acid leaching and electrowinning. The final feasibility study was expected in the first quarter 1997 (Reunion Mining, 1996; African Mining, 1996).

**Manganese.**—Production of manganese from Otjosondu Mine, 160 km northeast of Windhoek was 7.2% less than the 1995 output. Privately owned Purity Manganese in order to produce a more marketable product introduced selective mining during the year. The operation consisting of surface mining, followed by crushing, screening, and jigging recovers a marketable product of 45% manganese with a 0.035% of phosphorous content. Most of the manganese product was exported.

**Uranium.**—Responding to a rise in the long stagnant uranium market, Rossing Uranium Ltd., increased production of uranium oxide by over 20% to 2,890 in 1996. However, this still left the mine operating at only about 60% of capacity. Rossing, owned 68.6% by RTZ Corp. plc., planned to spend $10 million to rehabilitate the mine during 1996 and 1997. The 3-year refurbishment of the metallurgical plant, including the Continuous Ion Exchange plant was completed by the end of 1995. The company reported current ore reserves of 105,000 t of uranium oxide (Rossing Uranium Ltd., 1996). According to the Uranium Institute, Rossing was the fourth largest producing uranium mine in the world in 1996.

### *Industrial Minerals*

**Diamond.**—Production of diamonds in Namibia increased by nearly 3% in 1996 to 1.42 million carats. Namdeb Diamond Corp. accounted for 1.36 million carats of this output, all from onshore mining near the mouth of the Orange River.

De Beers Marine (DBM), a subsidiary of the South African-based De Beers Consolidated Mines, handled offshore marine mining for Namdeb, accounting for 30% of Namdeb diamond production in 1996. DBM developed new generation of undersea mining equipment, to mine lower-grade deposits economically. DBM's floating treatment plant with a 3,500-ton-per-hour capacity was tested during the year and the company planned to commission it in 1997. Namdeb's dredging project, which was to be commissioned in January 1997, incurred capital expenditure of $43 million in 1996. Also during the year, De Beers announced plans to establish a diamond cutting and polishing plant at Okahandja. Capital cost was estimated at $12 million and the plant was scheduled for operation in early 1998.

In early February 1996, Namco, a United Kingdom-based firm listed on the Vancouver and Namibian stock exchanges, announced plans to start commercial mining of diamonds in early 1997, following favorable bulk sampling results on its Hottentots Bay and Luderitz Bay marine concessions. The result of bulk samplings were not published. A third marine diamond miner, ODM was also expected to move from exploration to the production phase in 1997. For the fiscal year ending March 1997, ODM produced 57,000 carats from two offshore vessels while evaluating concessions within the 3 mile limit offshore from Luderitz (Mbendi, 1997a).

**Fluorspar.**—In 1996, Okorusu Fluorspar (Pty) Ltd. experienced a further decline in fluorspar production of 32,285 t compared with 36,889 t in 1995. The problem of excess silica in the new ore body was not resolved during the year. Exploration work continued in the permit area for a mineralogically suitable acid grade fluorspar. A new heavy media separation plant was purchased at the end of 1996 and was to be commissioned by February 1997. This new equipment may resolve the silica problem. The Ministry of Mines and Energy approved the company receiving a European Community, Sysmin, soft loan of $1.4 million to assist in removing 1.2 Mt of overburden needed to reactivate the "A" pit at Okorusu. Okorusu Fluorspar (Pty.) Ltd.'s major customer for acid grade fluorspar, Solvay, was negotiating to acquire an equity interest in the mine during 1996.

**Salt.**—Production of salt, industrial and refined, decreased in 1996, compared with 1995. The main reason for the decrease was the lack of a West African market, which was the major purchaser. Domestic sales of coarse salt were predominantly directed to the agricultural market which was plagued by the persistent drought during 1996. Sales of refined salt maintained a steady increase during the year and some 1,715 t were sold in 1996 as compared with 1,670 t in 1995.

Although there was tremendous potential for expansion of Namibian salt production, the industry is limited to extremely competitive pricing by other producers and is heavily influenced by transportation costs.

### *Mineral Fuels*

Namibia has held two licensing rounds in 1991 and 1994 to attract companies to explore the petroleum and natural gas potential of the country. Exploration to-date has identified four main offshore gas basins: (1) Namibe Basin, in the north, extending to Walvis Ridge, (2) Walvis Basin, (3) Luderitz Basin which covers an area from Walvis Basin to Luderitz and (4) Orange Basin, which extends to the south to South Africa's border.

The most promising field is the Kudu Block, which was originally discovered by Chevron in 1973. The Kudu Block is now held by Shell Exploration and Production BV of the Netherlands (75%), Texaco Namibia Resources of the United States (15%), and Energy Africa of South Africa (10%). Estimates by Namibia's national electricity company, NamPower, formerly Swawek, indicated that this field contained reserves of 85 billion cubic meters of low-sulfur natural gas and could achieve gas flow rates in excess of 2.1 million cubic meters per day. Intensive seismic studies indicate the potential for up to 283 billion cubic meters, sufficient to power a 2,000-megawatt powerplant for more than a century (U.S. Embassy, Pretoria, South Africa, 1996). Other reports indicate that Shell and the Kudu Field's other operators feel that these reserve estimates may be too optimistic and that Kudu recoverable gas reserves are more in the order of 56 billion cubic meters (Mbendi, 1997b). Namibia was targeting three outlets for the Kudu natural gas: the South African market; power generation; and steel, metallurgical, fertilizer, and petrochemical facilities probably at Walvis Bay. These considerations by Namibia parallel options being considered by Mozambique for development of the Pande natural gas field.

Other companies actively exploring for hydrocarbons in Namibia include: Chevron Overseas (Namibia) Ltd. (75%) and Energy Africa (25%) in Block 2815; Norsk Hydro (40%), Statoil (30%), and Saga (30%), all of Norway, in Block 1911; Sasol Ltd. of South Africa in Block 2012; and a joint venture between Canadian Ranger Oil (operators), Hardy Oil and Gas, and Amerada Hess in Block 2212.

## Reserves

Other than individual company reserve data reported in the above commodity discussions, an accounting of economic mineral reserves of the major producing mines in Namibia was not available for this review. An on-line discussion of the reserve and resource potential of mineral investment opportunities in Namibia is presented in project profiles by the Ministry of Mines and Energy (Ministry of Mines and Energy, 1997).

## Infrastructure

Namibia has two principal ports, Walvis Bay and Luderitz. Walvis Bay has container and bulk mineral-handling facilities and oil storage tanks. More than 1 Mt/yr of freight is handled at Walvis Bay, compared with 50,000 t/yr at Luderitz. Since the March 1994 return of Walvis Bay from South Africa, the Government has established the port as a free trade zone or Export Processing Zone (EPZ) and expects Walvis Bay to become an important commercial gateway for the southern African region. Namibia has a well-developed and maintained road transport system, with a railway network that links the principal centers of population to the coast and to South Africa. The country has about 40,000 km of roads, of which about 4,500 km is surfaced. A principal north-south axial road links southern Angola with South Africa, and east-west routes connects the coastal ports of Walvis Bay, Swakopmund, and Luderitz with South Africa and Botswana, respectively. The 2,400-km-long rail network is operated by TransNamib. The rail fleet consists of 100 diesel-electric locomotives and 2,400 railcars. Namibia's railways carry about 2 Mt/yr of freight.

Electricity throughout the country is provided by NamPower, the national power utility. Principal power stations include the 120-megawatt (MW) Van Eck coal burning plant in Windhoek and the 240 MW Ruacana hydroelectric station on the Kunene River. The NamPower network interconnects with South Africa's power grid. Consideration was being given by NamPower to building one or two more major gas powered electric powerplants to meet the country's future power needs and to reduce costly power imports.

## Outlook

With the final depletion and closure of the world famous Tsumeb copper-lead-zinc mine in 1996, there was some concern that the long tradition of mining in Namibia was waning. However, a reopening of the traditional diamond regions in the south to exploration for other commodities and the renewed interest in offshore and mainland mineral exploration opportunities by foreign investors has given hope for a new generation of mineral and energy projects in Namibia. Proposed new diamond, copper, and zinc mines, and the potential for new value added manufacturing or metal processing industries supported by the Kudu natural gas development should keep the mineral sector a central part of the economy of Namibia for the foreseeable future. In the longer run, greater development of regional transportation infrastructure in northern Namibia, including the Caprivi Strip could see Walvis Bay become a significant export route for new mineral developments in Angola and in the landlocked countries of Botswana and Zambia. With a climate that is among the driest in the world, Namibia will continue to deal with a lack of water resources as a constraint on development.

## References Cited

Africa Trade and Business Bulletin, 1998, Namibia Business and Investment Information, Imports and Exports Sections, undated (Accessed February 10, 1998, on the World Wide Web at URL http://www.mweb.co.za/achill/namibia/namibia.html).

African Mining, 1996, Low-cost zinc giant on the horizon for Reunion Mining: African Mining, Johannesburg, v. 2, no. 1, January-February 1997, p. 6.

Chamber of Mines of Namibia, 1995, Mining in Namibia: Chamber of Mines of Namibia, p. 9-10.

Iscor Ltd., 1996, Rosh Pinah Mine, Namibia: Iscor Ltd. media release, July 5, 1 p.

Metal Bulletin, 1996a, Haib copper partners launch $11.5 m study: Metal Bulletin, no. 8086, January 15, p. 7.

———1996b, Tsumeb copper smelter to start soon: Metal Bulletin, no. 8133, December 16, p.7.

Mbendi, 1997a, Namibia-Diamond mining industry: Mbendi Information Services, South Africa, October 31, 1997, 3 p. (Accessed February 3, 1998, on the World Wide Web at URL http://mbendi.co.za/indy/ming/mingnac2.htm).

———1997b, Namibia-Oil industry overview: Mbendi Information Services, South Africa, August 19, 1997, 3 p. (Accessed February 3, 1998, on the World Wide Web at URL http://mbendi.co.za/cynaoi.htm).

Mining Journal, 1997, Namibia Country Supplement: Mining Journal [London], v. 329, no. 8450, October 10, p. 15.

———1996a, Namibian copper hopes: Mining Journal [London], v. 326, no. 8364, February 9, p. 10.

———1996b, Tsumeb dispute resolved: Mining Journal [London], v. 329, no. 8451, October 11, 1997, p. 286.

———1996c, Western Metals Purchase: Mining Journal [London], v. 327, no. 8385, July 5, p. 7.

Ministry of Mines and Energy, 1997, Namibia business and investment information, mining investment opportunities in Namibia (see mining project links at end of text), November 26, 1997, (Accessed February 10, 1998, on the World Wide Web at URL http://www.mweb.co.za/achill/namibia/buspol/minopp/minopp.html 2/10/98).

Reunion Mining, 1996, Chairman's statement, preliminary results, 1996: Reunion Mining Plc., April 1, 8 p.

Rossing Uranium Ltd., 1996, Rossing's Namibia Newsletter: Rossing Uranium Ltd., January, 8 p.

U.S. Embassy, Windhoek, Namibia, 1996, Tsumeb strike turns ugly, mine's future in jeopardy: U.S. State Department Telegram 003012 (September 30, 1996), 3 p.

U.S. Embassy, Pretoria, South Africa, 1996, Namibia—Courting South African investment: U.S. State Department Telegram 004742 (May 16, 1996), 6 p.

## Major Sources of Information

Association of Prospectors and Miners of Namibia
P.O. Box 5059
Windhoek, Namibia
Telephone: (264) 61 34978
Fax: (264) 61 32809
The Chamber of Mines of Namibia
P.O. Box 2895
Windhoek, Namibia
Telephone: (264) 61 237-925 / 926
Fax: (264) 61 222-638
Geological Survey of Namibia
Private Bag 2168
45 Robert Mugabe Ave.
Windhoek, Namibia
Telephone: (264) 61 208-5111
Fax: (264) 61 249-146
Internet: http://www.gsn.gov.na/survey.htm
Ministry of Mines and Energy
Private Bag 13297
Trust Centre, Independence Ave.
Windhoek, Namibia
Telephone: (264) 61 226-571
Fax: (264) 61 238-643
Ministry of Trade and Industry
Private Bag 13340
Windhoek, Namibia
Telephone: (264) 61 229-933
Fax: (264) 61 220-227
Government Internet site:
http://www.republicofnamibia.com
Namibia National Small Miners Association
P.O. Box 7289
Windhoek, Namibia
Telephone: (264) 61 31088
Fax: (264) 61 31188

## Major Publications

Chamber of Mines of Namibia, Annual Report.
Geological Survey of Namibia, 1992. The Mineral Resources of Namibia, 598 p.

## TABLE 1
## NAMIBIA: PRODUCTION OF MINERAL COMMODITIES 1/ 2/

(Metric tons unless otherwise specified)

| Commodity | | 1992 | 1993 | 1994 | 1995 | 1996 |
|---|---|---|---|---|---|---|
| METALS | | | | | | |
| Antimony, sodium antimonate (47% Sb): | | | | | | |
| Gross weight | | 11 r/ | 13 r/ | 29 | -- | 16 |
| Sb content | | 5 r/ | 6 r/ | 14 | -- | 8 e/ |
| Arsenic, white, 99% arsenic trioxide | | 2,460 | 2,290 | 2,775 r/ | 1,661 | 1,302 |
| Beryl concentrate | | 10 e/ | 15 | -- | -- | -- |
| Cadmium metal, refined | | 33 | 13 | 19 | 15 e/ | 14 |
| Cesium, pollucite, gross weight e/ | | 5 | 5 | 5 | -- r/ | -- |
| Columbium and tantalum: Tantalite concentrate: e/ | | | | | | |
| Gross weight | kilograms | 200 | -- | -- | -- | -- |
| Cb content | do. | 30 | -- | -- | -- | -- |
| Ta content | do. | 30 | -- | -- | 112 3/ | -- |
| Copper: | | | | | | |
| Mine output, concentrate (29% to 30% Cu): | | | | | | |
| Gross weight | | 115,000 | 110,000 | 97,900 | 81,646 r/ | 57,005 |
| Cu content | | 31,300 | 29,500 | 28,400 | 22,530 r/ | 14,904 |
| Metal, blister 4/ | | 37,500 | 34,800 | 30,100 | 29,799 r/ | 20,705 |
| Gold | kilograms | 2,030 | 1,953 | 2,445 | 2,394 r/ | 2,145 |
| Lead: | | | | | | |
| Mine output, concentrate ( 30% to 32% Pb): | | | | | | |
| Gross weight | | 49,600 | 36,400 | 43,800 | 57,105 | 58,197 |
| Pb content | | 15,000 e/ | 11,600 | 13,000 e/ | 16,084 | 15,349 |
| Metal, refined, primary 4/ | | 31,700 | 31,200 | 23,800 | 26,752 | 18,849 |
| Manganese: Mine output, concentrate (44% Mn): | | | | | | |
| Gross weight | | -- | -- | -- | 95,385 | 88,573 |
| Mn content | | -- | -- | -- | 43,004 | 39,687 |
| Silver: Mine output, Ag content of concentrate | kilograms | 89,000 | 72,000 | 62,000 r/ | 69,000 r/ | 42,352 |
| Tin: Mine output, concentrate (61% to 67% Sn): | | | | | | |
| Gross weight | | 18 | 6 | 6 e/ | -- | -- |
| Sn content | | 11 | 4 | 4 e/ | 2 | -- |
| Uranium, $U_3O_8$ content of concentrate | | 1,958 r/ | 1,980 r/ | 2,235 r/ | 2,366 r/ | 2,890 |
| Zinc: Mine output, concentrate (49% to 53% Zn): | | | | | | |
| Gross weight | | 68,571 r/ | 34,557 r/ | 64,568 r/ | 59,290 | 66,106 |
| Zn content | | 36,100 | 17,624 r/ | 33,400 | 30,209 | 33,955 |
| INDUSTRIAL MINERALS | | | | | | |
| Diamond: | | | | | | |
| Gem e/ | thousand carats | 1,520 | 1,120 | 1,312 3/ | 1,382 3/ | 1,420 |
| Industrial e/ | do. | 30 | 20 | -- | -- | -- |
| Total 5/ | do. | 1,549 r/ | 1,141 r/ | 1,312 | 1,382 | 1,420 e/ |
| Fluorspar, concentrate, acid grade (97% $CaF_2$) | | 37,680 r/ | 43,466 r/ | 52,226 r/ | 36,889 r/ | 32,285 |
| Graphite e/ | | 200 | -- | -- | -- | -- |
| Gypsum e/ | | -- r/ | -- r/ | -- r/ | -- r/ | -- |
| Lithium minerals: | | | | | | |
| Amblygonite | | 5 | 5 | 5 e/ | 3 | 155 |
| Lepidolite | | 93 | 87 | 90 e/ | 106 | 355 |
| Petalite | | 1,060 | 647 | 650 e/ | 2,502 | 1,571 |
| Total | | 1,158 | 739 | 745 e/ | 2,611 | 2,081 |
| Salt 6/ | | 120,835 r/ | 132,585 r/ | 356,965 r/ | 303,986 r/ | 381,670 |
| Semiprecious stones: | | | | | | |
| Agate | | 40 r/ | 102 | 175 r/ | 115 | 150 |
| Amethyst | | 8,575 r/ | 100 | 338 r/ | 5 r/ | 19 |
| Chrysocolla | kilograms | 6,480 | 6,500 e/ | 6,500 e/ | -- | -- |
| Dioptase | do. | 35 | 50 e/ | 50 e/ | -- | -- |
| Quartz, crystal e/ | | 50 | 50 | 50 | -- | 15 |
| Rose quartz | | 124 | 166 | 170 | 200 | 190 |
| Sodalite | | 100 e/ | 354 | 1,143 r/ | 465 | 383 |
| Tourmaline | kilograms | 638 | 600 e/ | 600 e/ | -- | -- |
| Stone, sand and gravel: | | | | | | |
| Granite | | 7,313 r/ | 2,952 r/ | 11,585 r/ | 4,518 | 5,218 |
| Marble | | -- r/ | 13,359 r/ | 12,061 r/ | 16,935 | 10,525 |
| Quartz e/ | | 100 | 339 3/ | 350 | -- | -- |

See footnotes at end of table.

## TABLE 1--Continued
## NAMIBIA: PRODUCTION OF MINERAL COMMODITIES 1/ 2/

(Metric tons unless otherwise specified)

| Commodity | 1992 | 1993 | 1994 | 1995 | 1996 |
|---|---|---|---|---|---|
| INDUSTRIAL MINERALS--Continued | | | | | |
| Sulfur, pyrite concentrate: | | | | | |
| Gross weight (49% to 51% S) | 164,190 r/ | 113,703 r/ | 121,634 r/ | 103,140 | 90,735 |
| S content | 80,900 | 56,900 | 60,000 e/ | 51,330 | 45,338 |
| Wollastonite | 416 r/ | 824 | 1,309 r/ | 967 | 2,860 |

e/ Estimated. r/ Revised.

1/ Estimated data are rounded to three significant digits.

2/ Table includes data available through Feb. 26, 1998.

3/ Reported figure.

4/ Includes products of imported concentrate.

5/ Data may not add to totals shown because of independent rounding.

6/ The increase in 1994 is due to production from Walvis Bay previously included under South Africa.

## TABLE 2
## NAMIBIA: STRUCTURE OF THE MINERAL INDUSTRY FOR 1996

(Metric tons unless otherwise specified)

| Commodity | Major operating companies and major equity owners | Location of main facilities | Annual capacity |
|---|---|---|---|
| Copper | Tsumeb Corp. Ltd. (Gold Fields Namibia Ltd., 66%) | Tsumeb and Khusib Springs mines<br>Tsumeb smelter | 15,500 copper in concentrate,<br>58,000 blister copper. |
| Do. | do. | Kombat, 50 kilometers south of Tsumeb | 12,000 copper in concentrate. |
| Do. | Otjihase Mine (Tsumeb Corp. Ltd., 70% JCI Ltd., 30%) | Otjihase, near Tsumeb | 16,500 copper in concentrate. |
| Diamond thousand carats | Namdeb Diamond Corp. (Pty.) Ltd. (De Beers Centenary AG, 50%; Government, 50%) | Mines near Oranjemund; Elizabeth Bay Mine, 25 kilometers south of Luderitz; and marine operations. | 1,600. |
| Do. do. | Namibian Minerals Corp. | Marine operations offshore Luderitz and Hottentots Bay | 750. |
| Do. do. | Ocean Diamond Mining | Marine operations offshore Luderitz | 60. |
| Fluorspar | Okorusu Fluorspar (Pty.) Ltd. (Iscor Ltd., 26%; Okorusu Holdings) | Okorusu, 48 kilometers north of Otjiwarongo | 50,000, 98% calcium fluoride. |
| Gold | Erongo Mining and Exploration Co. Ltd. (Anglo American Corp.57.5%, Inmet Mining Corp. 20%; Randgold Ltd., 10%) | Navachab Mine near Karibib | 2 gold. |
| Lithium | SWA Lithium Mines (Pty.) Ltd. (Kloeckner; Matramco) | 30 kilometers south of Karibib | 1,500 concentrate. |
| Manganese | Purity Manganese (Namibia) Ltd. (private, 100%) | Otjosondu, 160 kilometers northeast of Windhoek | 100,000 ore with 45% manganese content. |
| Salt | Salt and Chemicals (Pty.) Ltd. (Sentrachem, 100% ?) | Walvis Bay | 350,000. |
| Do. | Salt Company (Pty.) Ltd. (private, 100%) | Swakopmund | 150,000. |
| Stone cubic meters | Karibib Mining and Construction Co. (Namibia) Ltd. (private, 100%) | Marble quarry at Karibib<br>Granite quarry | 2,500.<br>600. |
| Uranium | Rossing Uranium Ltd. (RTZ Corp. plc, 68.6%; Industrial Development Corp. of South Africa ; Government of Iran; Rio Algom, Canada) | Rossing, 30 kilometers east of Swakopmund | 5,000 uranium oxide. |
| Zinc | ImcorTin (Pty.) Ltd. (Western Metals Ltd., 100%; of which Iscor Ltd. holds 27% and Padaeng Industry 20%.) | Rosh Pinah Mine, 80 kilometers northeast of Oranjemund | 40,000. |

# THE MINERAL INDUSTRY OF

# NIGER

## By Philip M. Mobbs

Niger was an internationally important uranium producer, annually exporting concentrate containing approximately 3,000 tons of yellow cake. Other commercially exploited minerals were coal, gypsum, limestone, molybdenum, salt, and tin. The country had a significant area of greenstone belts under exploration for gold. According to the Ministry of Mines, Niger also had indications of barite, cobalt, columbium-tantalum, copper, chromite, graphite, iron ore, lead, lithium, monazite, molybdenum, nickel, phosphates, platinum-group metals, silver, talc, titanium, and zinc resources (Dikouma, 1993; Ministère des Mines, 1997). Mining accounted for approximately 4% of gross domestic product, which was estimated at approximately $1.8 billion for 1996.[1]

Law 93-016 of March 1993 and Decree No. 93-044/PM/MMEI/A of March 1993 provided the legal framework for the mining industry. The mining law provided a number of promotional incentives and guarantees, including duty-free import of capital equipment, guarantees against expropriation, and the right to repatriate earnings and dividends. Additional laws affecting the mineral industry include: the General Fiscal System, the General Customs and Excise System, the Exchange Regulation, the Labor Act, and the Trade Act. The Government retained 10% free equity in mining ventures and the option to purchase an additional 23% equity in mineral production ventures. There was a 5.5% royalty. The January 1996 military coup d'État and subsequent change of government did not appear to have adversely affected the remote mineral industry operations.

Gold exploration companies responded heartily to the Government's promotion of Niger's mineral resources. The three major greenstone gold belts in the Liptako region of west Niger were the focus of the gold rush. The Gorouol (or Kourki) Belt bordered Burkina Faso and Mali in the northwest of the Liptako area, the Sirba Belt was west of Niamey, and the Tera Gassa Belt was between the Gorouol Belt and the Sirba Belt (Bureau of Geological Consultancy, 1993). A number of small-scale miners were producing from operations in the Sirba Belt. Production of artisanal gold from the entire Liptako region was estimated at 1 metric ton per year.

In the Tera Gassa Greenstone Belt, Etruscan Enterprises Ltd. of Canada (23%) and Echo Bay Mines Ltd. of Canada (44%) drilled and trenched the Koma Bangou prospect. Echo Bay Mines subsequently sold its interest in the prospect to Etruscan. Etruscan submitted a feasibility study of the Koma Bangou prospect during 1996, effectively creating a joint venture with L'Office National des Ressources Minières (ONAREM) which held 23% of the project and controlled the State's 10% interest.

Etruscan also acquired 56% of African GeoMin Mining Development Corp. (AGMD), a subsidiary of Hansa GeoMin Consult GmbH of Germany. AGMD owned the Tiawa concession in the Sirba Greenstone Belt and had drilled the Samira deposit on the concession. AGMD completed a prefeasibility study which recommended additional exploration. In December, Placer Dome of Canada acquired substantial equity interest in Etruscan and acquired an option on 51% interest in the Samira deposit. At yearend, Etruscan initiated an airborne geophysical survey across the entire Tiawa concession.

Auspex Minerals Ltd. of Canada initiated geophysical and geochemical studies of the Koulbaga gold concession and agreed to buy out its joint-venture partner, Proma Minerals A/S of Norway, in the Tera Gassa Belt property.

Ashanti Goldfields Co. Ltd. of Ghana began exploration of the Tera gold property in October. The sampling program would allow Ashanti to earn 51% interest in the Tera Gassa Belt property from Carlin Resources Corp. of Canada. In the Sirba Greenstone Belt, Ashanti was earning up to 60% interest in the Nassile property from Royalstar Resources Ltd. of Canada. International African Mining Gold Corp. and Ashanti were drilling and trenching on Libiri prospect on the Saoura concession, north of the Nassile concession.

First Quantum Minerals Ltd. of Canada, formerly First Quantum Ventures Ltd., was sampling stream sediments on the Sakoira gold exploration permit of Reunion Mining Plc. of the United Kingdom. The Tera Gassa Belt property, approximately 120 kilometers (km) northwest of Niamey, was, unlike any other Liptako concession, east of the Niger River. First Quantum had the right to earn 45% interest in the Sakoira property.

Imperial Metals Corp. of Canada and Sumitomo Corp., a subsidiary of Sumitomo Metal Industries, Ltd. of Japan, were drilling on the M'Banga concession, 50 km west of Niamey in the Sirba Belt.

In the Gorouol Belt, Berlant General Trading Establishment of Kuwait obtained the Kossa concession and Proma Minerals SA of Norway was awarded the Tin-Awati concession during 1996. In October 1996, EXP Resources Ltd. of Canada (formerly Explogas Inc. of Canada) obtained an option from Proma to acquire 60% interest in Tin-Awati.

Also reportedly exploring in Niger were Al-Qudairi International Trading and Contracting of Kuwait on the

---

[1] Where necessary, values have been converted from Communauté Financière Africaine (CFA) francs to U.S. dollars at the exchange rate of CFA franc 523=US$1.00 in 1996.

Tringui concession in the Tera Gassa Belt, Barrick Gold Corp. of Canada on the Tialkam concession in the Sirba Belt, and Pioneer Goldfields Ltd. of the United Kingdom, a subsidiary of Pioneer Group, Inc. of the United States on the Deba concession in the Sirba Belt (African Mining, 1997; American Embassy, Niamey, 1997).

Small quantities of tin ore were mined by private individual operators at El Mécki, Tarouadji, Timia, Agahak, and Guissat in the Aïr Mountains of central Niger, northeast of Agadez.

Uranium concentrates were produced by two companies, the Société des Mines de l'Aïr (SOMAÏR) and Compagnie Minière d'Akouta (COMINAK). Uranium remained the main mineral commodity mined in Niger and represented a large percentage of the country's foreign exchange earnings. SOMAÏR operated its open pit mine northwest of Arlit, approximately 250 km northwest of Agadez. Compagnie Générale des Matières Nucléaires (COGEMA) of France owned 56.9% of the company; ONAREM held 36.6%; and Urangesellschaft, a COGEMA subsidiary, had a 6.5% holding in SOMAÏR. COMINAK's underground operations were approximately 10 km southwest of SOMAÏR, near Akouta. COMINAK was a joint-venture mining operations between COGEMA (34%), ONAREM (31%), Overseas Uranium Resources Development Co. of Japan (25%), and the Spanish Co., Empresa Nacional del Uranio S.A. (10%). The miners at SOMAÏR were out on strike in February and March. COMINAK operations were subject to a 3-week sympathy strike by its workers in March.

Production of industrial minerals and mineral fuels was limited to a few commodities, such as cement, coal, gypsum, limestone, salt, and sand and gravel, which was consumed domestically.

Exxon Corp. of the United States and its partner Elf Aquitaine of France continued hydrocarbon exploration in the southeast. The Government was interested in leasing additional hectares in the East Niger Basin to stimulate petroleum exploration activity.

There were 11,258 km of highway. The Government approached the European Union for Sysmin funding to upgrade the nation's road network in the west to improve access to the Liptako gold district. The ports of Abidjan, Côte d'Ivoire, and Cotonou, Benin, were connected by railroad to terminals at Ouagadougou, Burkina Faso (approximately 500 km by highway from Niamey) and Parakou, Benin (approximately 560 km by highway from Niamey), respectively. Highways linked Niamey with ports at Accra, Ghana; Abidjan; Cotonou; Lagos, Nigeria; and Lomé, Togo.

Uranium will probably remain the most important mineral commodity produced in Niger and the largest foreign exchange earner for the immediate future; however, the projected shallow, open pit gold mines have excellent potential to allow the gold sector to become a factor in the nation's economy. Development of other resources, such as iron ore, petroleum, and phosphates, have the potential to provide additional jobs and foreign exchange revenue for the country.

### References Cited

African Mining, 1997, Gold exploration in Niger shows promise: African Mining, v. 2, no. 1, p. 11.

American Embassy, Niamey, 1997, Update on gold in Niger--Investment and exploration continue: U.S. State Department Cable - Niamey 001176, (March 7, 1997), p. 2.

Bureau of Geological Consultancy, 1993, Golden Opportunities in Liptako: Bureau of Geological Consultancy, Brussels, Belgium, 30 p.

Dikouma, M.S., 1993, Guide of the Mining Investor: Niamey, Niger, Ministère des Mines et de l'Energie, 53 p.

Ministère des Mines, 1997, Les Opportunités d'Investissements Miniers: Ministère des Mines, Niamey, Niger, 34 p.

### Major Sources of Information

Ministère des Mines, de l'Industrie et de la Technologie
B.P. 11700
Niamey, Niger
Telephone: (227) 73-45-82
Fax: (227) 73-28-12

Office National des Ressources Minières
B.P. 12716
Niamey, Niger
Telephone: (227) 73-59-25
Fax: (227) 73-28-12

### Other Publication

Mining Journal (London), 1993, Niger Country Supplement: Mining Journal, v. 321, no. 8234, July 23, 12 p.

## TABLE 1
## NIGER: ESTIMATED PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

| Commodity 2/ | | 1992 | 1993 | 1994 | 1995 | 1996 |
|---|---|---|---|---|---|---|
| Cement, hydraulic | | 29,288 3/ | 29,200 | 29,200 | 30,000 | 30,000 |
| Coal, bituminous | | 133,525 3/ | 133,500 | 133,500 | 135,000 | 140,000 |
| Gold | | 1 | 1 | 1 | 1 | 1 |
| Gypsum | | 1,750 | 1,700 | 1,700 | 1,800 | 1,800 |
| Molybdenum concentrate, Mo content | | 10 | 10 | 10 | 10 | 10 |
| Salt | thousand metric tons | 3 3/ | 3 | 3 | 3 | 3 |
| Tin, mine output, Sn content | | 20 | 20 | 20 | 20 | 10 |
| Uranium | | 2,970 3/ | 2,914 r/ | 2,975 r/ | 3,150 r/ | 3,160 |

r/ Revised.

1/ Includes data available through July 1997.

2/ In addition to the commodities listed, phosphate, tungsten, and a variety of construction materials (clays, sand and gravel, and stone) are produced; but information is inadequate to make reliable estimates of output.

3/ Reported figure.

## THE MINERAL INDUSTRY OF

# NIGERIA

### By Philip M. Mobbs

Nigeria was Africa's largest oil producer in 1996. According to the U.S. Department of Energy's Energy Information Administration, Nigeria ranked 11th in world production of crude petroleum by volume, accounting for about 3% of world production and about 8% of the Organization of Petroleum Exporting Countries' total production (Energy Information Administration, 1997a). The oil sector remained a mainstay of the Nigerian economy, providing about 80% of total Government revenues and accounting for more than 90% of the country's total export earnings. In 1995, the last year for which sector data are available, agriculture accounted for 38.5% and oil and gas accounted for 12.4% of the nation's gross domestic product (GDP) (OPEC Bulletin, 1996). In 1996, GDP was estimated to have grown 3.25% compared with a 2.2% growth rate in 1995 and inflation was down to 28% in 1996 compared with the 72.8% recorded in 1995 (Goldman, 1997a).

Mineral rights were held by the Federal Government. Several laws and associated regulations and amendments addressed mineral operations, including the Explosives Act of 1964, the Quarries Act of 1969, the Nigerian Mining Corporation Act of 1972, the Gold Trading Act of 1990, and the Investment Promotion Decree of 1995. Additional legislation, including the Oil Pipelines Act of 1956, the Land Use Act of 1978, the Associated Gas Re-Injection Act of 1979, and the Oil Mineral Producing Areas Development Commission Decree of 1992, regulated petroleum and natural gas operations.

Environmental guidelines or regulations included the Federal Environmental Protection Agency Act of 1988, the Effluent Limitation Regulations of 1991, the Pollution Abatement Regulations of 1991, the Pollution Control Guidelines of 1991, the Solid and Hazardous Waste Regulations of 1991, the Environmental Impact Assessment Decree of 1992, the Federal Environmental Protection Agency (amendment) Decree of 1992, and the Harmful Waste Act of 1992.

The Ministry of Solid Minerals Development was involved in the promotion, exploration, and exploitation of Nigeria's solid minerals. *(See table 1.)* The Ministry of Petroleum Resources concerned itself with the oil and natural gas segment of the mineral industry. Environmental regulations were administered by The Federal Environmental Protection Agency and the Department of Petroleum Resources of the Ministry of Petroleum Resources.

The ubiquitous Nigerian advanced-fee fraud was undermining the credibility of a number of Nigerian agencies, especially Nigerian National Petroleum Corp. (NNPC) and the Central Bank. The notorious worldwide scam, also know as 419 fraud, named for the applicable section of Nigerian criminal code, typically proposed to temporarily transfer large amounts of money, usually alleged to be diverted from bribes, kickbacks, or NNPC contracts, to the victim's bank account in return for a significant fee (U.S. Trade Representative, 1997; Washington Post, 1997).

Nigeria was the fifth largest source of imported crude oil to the United States. Exporting approximately 218 million barrels to the United States in 1996, Nigeria accounted for 8% of the United States total crude oil imports, trailing only Venezuela, Saudi Arabia, Mexico, and Canada, in order of volume (Energy Information Administration, 1997b, p. 278-301). The United States continued to be the largest importer of Nigerian crude oils, accounting for about 34% of the country's crude oil and petroleum products exports in 1996. Other major consumers of Nigerian crude were France, the Netherlands, Spain, and the Economic Community of West African States member countries. Nigerian mineral exports also included coal, tin, and some industrial minerals.

The Government was determined to attract foreign investment, especially in the solid minerals sector. According to the Ministry of Solid Minerals Development, the country had considerable mineral wealth and potential for the development of the additional minerals (Wall Street Journal, 1997). The federal administration was actively encouraging the diversification of the mineral industry (Nigeria Ministry of Solid Minerals Development, 1997). The Government was attempting to revive production of barite, kaolin, gold, marble, and tin, as well as formalizing operations at deposits that had been developed by unlicensed artisanal miners (Nigeria Ministry of Solid Minerals Development, 1996).

As part of the Nigerian Minerals Appraisal and Monetisation Program consortium, Behre Dolbear & Co. Inc. of the United States, AMTEC International Ltd. of France, and Global Minerals Ltd. of Nigeria compiled a formal data base of known mineral deposits in Nigeria. Behre Dolbear was preparing to evaluate designated deposits for the Government, which in turn proposed to develop any economically viable deposit by encouraging international mining companies to lease the prospect or to form joint ventures with state companies.

All minerals with significant production were produced by parastatal companies or joint-ventures with the Government. *(See table 2.)* The oil and gas sector accounted for 90% of U.S. investment in Nigeria. Since the Nigerian Investment Promotion Commission Decree was promulgated in 1995, international investors have been authorized to purchase stock in most local mineral companies; however, the petroleum sector was excluded. Nominally, total foreign equity ownership in the petroleum sector was limited to 40% of each venture with the remainder held by the state-owned NNPC. Other major parastatal agencies were the Nigerian Coal Corp., the Nigerian Mining Corp. and its subsidiaries, including Nigerian Barytes Mining and Processing Co. Ltd. and Gold Mining Co. Ltd.; the Nigerian Steel Development Authority; and a number of companies in which the Nigerian Mining Corp. has equity interest, including Consolidated Tin Mines Ltd., Cross River Limestone Co. Ltd., Jakura Marble Industry Ltd., Makeri Smelting Co., Ltd., Nigeria Uranium Mining Co. Ltd., Nigerian Diatomite Co. Ltd., and Nigerian Marble Mining Co. Ltd.

The Government announced that it was arranging new petroleum joint ventures with NNPC and China National Petroleum Corp., Petronas Bhd. of Malaysia, and the Daewoo Corp. of South Korea (Africa Energy & Mining, 1996). During October 1996, the Finance Ministry proposed to gradually divest the Government's stake in oil joint-venture operations, to privatize the country's four refineries, to spin off the state power companies, and to authorize two privately owned petroleum refineries dedicated to exporting output.

The proposed October 1996 commissioning of the Aluminum Smelter Co. of Nigeria (Alscon) smelter was postponed until 1997. The delay was attributed initially to the need to dredge the Imo River and subsequently to difficulties in obtaining a contract on an alumina supply. The two-pot-line 180,000-metric-ton-per-year (t/yr) smelter at Ikot Abasi, Cross River State, was owned by the Nigerian Government, 70%; Ferrostaal AG of Germany, 20%; and Reynolds International of the United States, 10%. The company intended to initially import up to 375,000 t/yr of bauxite from Guinea and subsequently to process locally produced bauxite as the domestic industry develops. Reynolds Metals Co. of the United States was to purchase Alscon's projected exports of 140,000 t/yr of primary aluminum (Reynolds Metals Co., 1997).

The Nigerian steel industry comprised Delta Steel Co. Ltd. at Aladja, near Warri, and the under-construction Ajaokuta Steel Complex at Ajaokuta. Additionally, there were rolling mills at Jos, Katsina, and Oshogbo. The Ajaokuta plant was not completed in 1996, and Delta Steel reportedly was idle from May 1996 through the end of the year (Metal Bulletin, 1997a).

The Government reinstituted its ban on gypsum imports in mid-1996 as an incentive to develop the Nigerian gypsum industry. Additionally, the Government prohibited imports of barite and kaolin in June 1996 and petroleum products imports in September 1996. Also during 1996, the Ministry of Petroleum Resources introduced regulations to increase oilfield employment opportunities for Nigerian citizens and to reduce expatriate staff. NNPC joint-venture partnerships were required to award oilfield service contracts to Nigerian-registered companies. The Ministry also declared that NNPC joint-venture partnerships would be required to utilize offshore production platforms fabricated in Nigeria (Journal of Petroleum Technology, 1997). The Government also authorized the Ministry to reclaim marginal, nondeveloped properties of joint ventures of the NNPC and multinational oil companies and to reassign them to small local companies. Approximately 183 fields were identified as marginal (World Oil, 1997).

Of the natural gas produced in Nigeria, about 79% was flared and 9% marketed, while another 9% was reinjected. The remainder was used in the field for power generation. When the oil industry infrastructure was being installed in the 1960's and 1970's, there was no domestic demand for Nigerian natural gas. Cheap oil further undercut any economic incentives to build gas infrastructure in the Delta region. Because no facilities were initially built to collect, treat, compress, and transport the low-pressure associated gas produced with the oil, excess gas has been flared for the past 40 years. Nigerian gas flares have become an international environmental issue.

The traditional lack of natural gas demand in Nigeria was beginning to change. Recent legislation increasingly encouraged local consumption or the reinjection of gas into producing reservoirs as opposed to flaring. Additionally, the royalty rate for onshore gas production was set at 7% compared with 20% royalty for onshore crude petroleum production. Offshore, the rates were 5% for gas and 18.65% for oil.

During 1996, only Nigeria Gas Co. (NGC), a unit of NNPC, bought gas from producers. The primary supply was nonassociated gas produced by Shell Petroleum Development Co. of Nigeria Ltd. (Shell Nigeria), the largest oil producer in the country. NGC sold most of its gas to Nigeria Electric Power Authority powerplants and to the National Fertilizer Co. of Nigeria in Onne.

Mobil Producing Nigeria Unlimited and NNPC planned a joint venture for estimated $810-million offshore natural gas liquids (NGL's) extraction facility to process associated gas produced with condensate at the Oso Field. Recovered liquids were to be piped 67 kilometers (km) to Bonny Island, where up to 50,000 barrels per day (bbl/d) of NGL's would be separated into propane, butane, and pentane. Processed gas would be reinjected to maintain reservoir pressure in the Oso Field.

Nigeria Liquified Natural Gas Ltd. (Nigeria LNG) suffered another setback in December 1996 when ENEL SpA, the Italian electrical utility, canceled its contract to take about one-half of the output from Nigeria LNG's proposed 5.78-million-metric-ton-per-year-capacity[1] liquefied natural gas (LNG) liquefaction plant at Finima on Bonny Island. ENEL was unable to obtain permission to build a LNG terminal at Montalto di Castro, Italy. Environmental resistance caused ENEL's proposed secondary site at Monfalcone, Italy, to be abandoned also. With Enagas of Spain contracted for 1.66 billion cubic meters per year (billion $m^3$/yr) of natural gas, Gaz de France committed to take 1.2 billion $m^3$/yr, and Botas of Turkey to import 200 million $m^3$/yr, Nigeria LNG was continuing with the $4-billion Finima project. NNPC held 49% of the Finima project, with Royal Dutch/Shell Group of the Netherlands and the United Kingdom owning 25.6%, Elf

---

[1] Upon regasification at the discharge terminals, the proposed annual plant output will be equivalent to 7.15 billion cubic meters of liquefied natural gas.

Nigeria Ltd. holding 15%, and Azienda Generali Italiana Petroli SpA. (Agip) of Italy with 10.4%.

Shell Nigeria was building a gas processing plant at Soku, Rivers State, to supply approximately 13 million cubic meters per day (Mm³/d) of natural gas to the Nigeria LNG plant at Finima. Gas will come from the Soku, Ekulama, and Nembe Creek oilfields (Shell Nigeria, 1996). Finima was also to receive gas from Agip and Elf.

Shell Nigeria will be supplying approximately 3 Mm³/d of gas to the Alscon smelter at Ikot Abasi. Shell Nigeria was investigating demand for gas at a number of additional industrial projects. Furthermore, Shell Nigeria planned to increase the volume of associated gas it reinjected into producing fields, and the company was curtailing production from high gas-oil ratio wells (Shell Nigeria, 1997b).

Chevron Nigeria Ltd. and NNPC continued construction of a liquefied petroleum gas extraction plant at Escravos. The plant will process gas from the Okam and Mefa Fields to recover propane and butane. The proposed West African Gas Pipeline to Benin, Togo, and Ghana was targeted as a customer for the plant's natural gas to supplement sales to NGC.

Production of crude petroleum remained stable. Most production was from relatively small onshore fields in the southern part of the country in the delta of the Niger River, with nearly all the rest produced from offshore wells. Oil exploration activity had moved offshore.

Nigeria had four oil refineries—one in Kaduna, two in Port Harcourt, and one in Warri—with a combined capacity of 445,000 bbl/d. All refineries were producing below capacity. Refinery problems were attributed to various causes, including general inefficiency, poor maintenance, poor management, sabotage, and spare parts shortages. Additionally, product pipelines to population centers in the interior were damaged repeatedly when fuels were illegally diverted from the pipelines.

Partially in response to the international attention attracted by the environmental problems of the Delta region, Shell Nigeria accelerated its facilities replacement program and replaced a number of flowlines in the Delta swamps during 1996. Shell Nigeria suffered approximately 320 oil spills in 1996 with losses of about 25,000 barrels attributed to 100 sabotage acts. Corrosion and operational incidents accounting for 220 spills totaling approximately 13,000 barrels (Shell Nigeria, 1997a). Under Nigerian law, oil companies did not pay compensation for spills caused by sabotage; however, companies often were forced to pay local communities to allow cleanup teams access to vandalized sites. In addition to environmental problems directly attributable to the mineral industry, such as the oil spills and gas flares, Nigeria's environment was affected by deforestation, soil erosion, and overintensive farming attributed to the rapidly expanding population of the Delta region.

The indigenous population of the delta directed a wide range of demands at operating companies for electricity, employment, flood walls, road building, schools, and potable water supply. Companies were subject to anti-Federal Government protests in addition to sabotage, vandalism, and general violence directed at their facilities and staff.

The Nigerian railway system consists of 3,510 km of 1.067-meter-gauge track. The two main north-south lines, from Lagos to Kano (1,126 km) and from Port Harcourt to Maiduguri (1,443 km), were connected by a 179-km east-west line from Kaduna to Kafanchan. Lines such as the Ajaokuta-Port Harcourt spur were used to transport goods and mineral commodities to ports. China had agreed to fund a $250-million project to renovate the railway system (The Economist, 1996a). Roads totaled about 143,000 km. The roads were generally in poor condition because they were heavily used and poorly maintained. Inland waterways of about 9,000 km consisted mainly of the Niger and Benue Rivers; these also served as routes for commodity transport. Major ports from west to east included Apapa and Tin Can Island in Lagos, Koko near Warri, Port Harcourt, and Calabar.

Development of other nonfuel minerals would broaden the country's industrial base. The Government's fiscal and financial incentive programs were designed to attract local and foreign investors into new investments in the mineral industry. However, the country's reputation for civil strife, corruption, fraud, political uncertainty, and the threat of international sanctions apparently tempered international investor's interest (Economist, 1996b; Goldman, 1997b; Knott, 1997; Metal Bulletin, 1997b; Wall Street Journal, 1997). Petroleum was expected to continue to dominate the economy for the foreseeable future, despite reduced funding of NNPC by the Government that resulted in NNPC's deferral of payments for its share of joint-venture operations. Continued deferral of NNPC payments could result in significantly reduced petroleum exploration and field development, and could adversely affect the Government's target of increasing crude oil production by 50% by the turn of the century (Corzine, 1997).

The Government proposed to eliminate natural gas flaring by 2010. With the development of the export and local industrial markets, natural gas could eventually approach oil's importance to the Nigerian economy. The utilization of Nigerian natural gas could provide a reliable energy source for the West African region and a feedstock for the Nigerian chemical and petrochemical industries. Completion of the West African gas pipeline would provide Nigeria with additional revenue and regional goodwill.

Major changes in Government policy and programs could affect industrial development, particularly the nonfuel minerals industry. Successful development of the aluminum sector could enhance the growth of peripheral industries and would provide needed jobs for the labor force. Revitalization of the coal industry could provide an additional source of foreign exchange when fully exploited. The mineral industry as a whole should continue to enjoy considerable growth because of increasing activity in the mineral fuels sector.

## References Cited

Africa Energy & Mining, 1996, Privatization for oil industry?: Africa Energy & Mining, no. 190, October 9, p. 2.

Corzine, Robert, 1997, Nigerian oil funding crisis deepens: London, Financial Times, August 8, 1997, p. 4.

Economist, The, 1996a, Hallo, China—or is it Taiwan?: The Economist, v. 340, no. 7983, September 14, p 44.

_____1996b, Abacha wins: The Economist, v. 341, no. 7991, November 9, p. 46.
Energy Information Administration, 1997a, International Petroleum Statistics Report—August 1997: Washington, D.C., Energy Information Administration, DOE/EIA-0520(97/08), p 4-6.
_____1997b, Petroleum Supply Annual 1996: Washington, DC, DOE/EIA-0520(97/08), 599 p.
Goldman, Antony, 1997a, Nigeria's budget disappoints reformers: London, Financial Times, January 20, 1997, p.4.
_____1997b, Nigeria shapes budget with eye to rural poor: London, Financial Times, January 23, 1997, p. 6.
Journal of Petroleum Technology, 1997, Dateline—Nigeria: Journal of Petroleum Technology, v. 49, no. 1, p. 67.
Knott, David, 1997, Interest grows in African oil and gas opportunities: Oil & Gas Journal, v. 95, no. 19, May, 12, p 41-47.
Metal Bulletin, 1997a, Another blow for Nigerian steel: Metal Bulletin, no. 8161, March 13, p 36.
_____1997b, Nigeria's image stalls investments: Metal Bulletin, n. 8210, September 11, p. 9.
Nigeria Ministry of Solid Minerals Development, 1996, Solid Minerals Development in Nigeria: Abuja, Nigeria, Ministry of Solid Minerals Development, 34 p.
_____1997, Brief on Nigeria's mining potentials: Abuja, Nigeria, Ministry of Solid Minerals Development, 17 p.
OPEC Bulletin, 1996, Nigerian economy grew by 2.2 per cent in 1995: OPEC Bulletin, v. 27, n. 10, p. 58 .
Reynolds Metals Company, 1997, Form 10-K for period ending December 31, 1996: Securities and Exchange Commission, no pagination. (Accessed September 5, 1997, on the World Wide Web at URL http://www.sec.gov/cgi-bin/srch-edgar/ via keyword Reynolds+ADJ+Metals)
Shell Nigeria, 1996, Shell joint venture to reduce gas flaring in Nigeria: Shell Petroleum Development Co., October 18, 1996, 1 p. (Accessed September 9, 1997, on the World Wide Web at URL http://www.shellnigeria.com/news/prl19.html)
_____1997a, Annual report 1996: Shell Petroleum Development Co., July 23, 1997, 38 p. (Accessed September 9, 1997, on the World Wide Web at URL http://www.shellnigeria.com/abshell/agm2.html)
_____1997b, Harnessing gas: Shell Petroleum Development Co., May 1, 1997, 14 p. (Accessed September 9, 1997, on the World Wide Web at URL http://europe.shellnigeria.com/abshell/harnessing.html).
U.S. Trade Representative, 1997, 1997 National Trade Estimate—Nigeria: U.S. Trade Representative, Washington, DC, p 281-285 (Accessed April 18, 1997, on the World Wide Web at URL http://www.ustr. ov/reports nte/1997 nigeria pdf)
Wall Street Journal, 1997, Opportunities in the solid minerals sector: advertising supplement to the Wall Street Journal, April 21, 1997, p. D10.
Washington Post, 1997, Central Bank of Nigeria—press statement on advanced fee fraud scam—you have been warned:, September 3, 1997, p A21.
World Oil, 1997, Nigeria: World Oil, v. 218, no. 8, p. 118.

## Other Sources of Information

Ministry of Solid Minerals Development
New Secretariat Complex
Annex 3, 5th Floor
Abuja, Nigeria
Nigerian National Petroleum Corporation
NNPC Building Falomo
Lagos, Nigeria
Telephone: (234) 1-261-4650

# TABLE 1
# NIGERIA : PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

| Commodity 2/ | | 1992 | 1993 | 1994 | 1995 | 1996 e/ |
|---|---|---|---|---|---|---|
| METALS | | | | | | |
| Columbium and tantalum concentrates: | | | | | | |
| Gross weight e/ | | 90 r/ | 40 | 30 | 30 | 30 |
| Columbium content | | 38 r/ | 17 | 17 r/ | 13 e/ | 13 |
| Gold | grams | 1,800 | 1,400 | 4,800 | 5,000 e/ | 6,000 |
| Iron and steel: e/ | | | | | | |
| Iron ore, gross weight | thousand tons | 400 | 400 | 400 | 168 | 100 |
| Steel, crude | do. | 200 | 150 | 105 3/ | 36 | 20 |
| Lead, metal, refined e/ | do. | 5 | 5 | 4 | 4 | 4 |
| Tin: | | | | | | |
| Mine output, cassiterite concentrate: | | | | | | |
| Gross weight e/ | | 568 3/ | 200 r/ | 278 | 600 r/ | 3,000 |
| Sn content | | 415 | 175 r/ | 185 | 500 r/ e/ | 2,200 |
| Metal, smelter | | 370 | 169 r/ | 179 | 400 r/ e/ | 2,000 |
| INDUSTRIAL MINERALS | | | | | | |
| Cement, hydraulic | thousand tons | 3,200 e/ | 3,200 e/ | 2,600 | 3,000 | 3,000 |
| Clays: e/ | | | | | | |
| Kaolin | | 1,300 | 1,300 | 105,000 3/ | 105,000 3/ | 105,000 |
| Unspecified | | 60,100 | 60,100 | 104,000 r/ | 100,000 r/ | 100,000 |
| Feldspar e/ | | 700 | 700 | 1,000 r/ | 1,000 r/ | 1,000 |
| Nitrogen: e/ | | | | | | |
| N content of ammonia | thousand tons | 337 3/ | 350 | 350 | 350 | 400 |
| N content of urea | do. | 486 3/ | 400 | 400 | 400 | 500 |
| Stone: | | | | | | |
| Limestone | do. | 1,400 | 1,400 e/ | 2,700 | 2,700 e/ | 2,700 |
| Marble | do. | 11 r/ | 3 r/ | 8 r/ | 8 r/ | 10 |
| Shale | do. | 87 r/ | 195 r/ | 32 r/ | 500 e/ | 500 |
| Topaz 4/ | kilograms | 1,677 | 834 | 1,022 | 1,000 e/ | 1,500 |
| MINERAL FUELS AND RELATED MATERIALS | | | | | | |
| Coal, bituminous e/ | | 86 r/ 3/ | 50 r/ | 130 r/ | 22 | 30 |
| Gas, natural: e/ | | | | | | |
| Gross | million cubic meters | 32,000 3/ | 31,300 | 34,000 r/ | 35,000 | 37,000 |
| Dry | do. | 2,897 3/ | 2,600 | 4,600 r/ | 5,000 r/ | 6,000 |
| Petroleum: | | | | | | |
| Crude | thousand 42-gallon barrels | 710,000 | 748,000 | 743,500 | 740,000 | 756,000 |
| Refinery products: | | | | | | |
| Gasoline | do. | 33,200 | 30,800 | 23,000 r/ | 20,500 e/ | 23,000 |
| Jet fuel e/ | do. | 2,500 | 500 | 500 | 1,000 | 1,000 |
| Kerosene | do. | 12,000 | 14,500 | 12,000 r/ | 7,500 e/ | 10,000 |
| Distillate fuel oil | do. | 22,000 | 15,500 | 22,000 r/ | 16,000 e/ | 20,000 |
| Residual fuel oil | do. | 18,600 | 800 | 20,000 r/ | 13,500 e/ | 18,000 |
| Unspecified | do. | 8,700 | 1,000 | 13,500 r/ | 1,500 e/ | 8,000 |
| Total | do. | 97,000 | 63,100 | 91,000 | 60,000 e/ | 80,000 |

e/ Estimated. r/ Revised.

1/ Includes data available through Sept.12, 1997.

2/ In addition to the commodities listed, amethyst, aquamarine, barite, diamond, emerald, garnet, granite, gypsum, phosphate rock, sapphire, soda talc, tourmaline, zinc, zircon, and a variety of crude construction materials (stone, sand and gravel) are produced; but information is inadequate to estimate output.

3/ Reported figure.

4/ Exports.

## TABLE 2
## NIGERIA: STRUCTURE OF THE MINERAL INDUSTRY FOR 1996

(Thousand metric tons unless otherwise specified)

| Commodity | | Major operating companies and major equity owners | Location of main facilities | Annual capacity |
|---|---|---|---|---|
| Cement | | West Africa Portland Cement Co. (Associated International Cement, 39.4%; Odu'a, 26.8%; public, 17.2%; Government, 16.6%) | Ewekoro<br>Shagamu | 750.<br>600. |
| Coal | | Nigerian Coal Corp. (Government, 100%) | Enugu | 150. |
| Iron ore | | National Iron Ore Mining Co. (Government, 100%) | Itakpe, near Okene | 1,300. |
| Iron and steel | | Ajaokuta Steel Co. Ltd. (Government, 100%) | Ajaokuta | (1/) |
| | | Delta Steel Co. Ltd. (Government, 100%) | Aladja | 1,000. |
| | | Jos Steel Rolling Co. Ltd. (Government, 100%) | Jos | 210. |
| | | Katsina Steel Rolling Co. Ltd. (Government, 100%) | Katsina | 210. |
| | | Oshogbo Steel Rolling Co. Ltd. (Government, 100%) | Oshogbo | 210. |
| Nitrogen | | National Fertilizer Co. of Nigeria (Government, 63%; M.W. Kellog, 37%) | Onne | 548 N content of ammonia, and 360 N content of urea. |
| Petroleum: | | | | |
| Crude | million 42-gallon barrels | Nigerian National Petroleum Corp. (NNPC) joint ventures (Government, 60%; private, 40%) 2/ | Niger River delta | 760. |
| Refinery products | do. | New Port Harcourt refinery (Government, 100%) | Port Harcourt | 55. |
| | do. | Warri refinery (Government, 100%) | Warri | 43. |
| | do. | Kaduna refinery (Government, 100%) | Kaduna | 38. |
| | do. | Old Port Harcourt refinery (Government, 100%) | Port Harcourt | 22. |
| Tin | | Makeri Smelting Co. Ltd. (Government, 100%) | Jos | 2. |

1/ Construction of the 1.2-million-metric-ton-per-year plant was stalled.

2/ Includes, in order of volume, Shell Nigeria joint venture (NNPC, 55%; Royal Dutch/Shell Group, 30%; Elf Nigeria Ltd., 10%; and Agip SpA, 5%), Chevron joint venture (NNPC, 60% and Chevron Nigeria Ltd., 40%), Mobil joint venture (NNPC, 60% and Mobil Producing Nigeria Unlimited, 40%), Agip-Phillips joint venture (NNPC, 60%; Agip SpA, 20%, and Phillips Oil Co. Ltd. of Nigeria, 20%), Elf joint venture (NNPC, 60% and Elf Group, 40%), Texaco/Chevron joint venture (NNPC, 60%, Texaco Inc., 20%, and Chevron Nigeria Ltd., 20%), and NNPC petroleum sharing contracts with the Ashland Nigeria Exploration Unlimited-Total Exploration Nigeria Ltd. joint venture and with Agip Energy.

## THE MINERAL INDUSTRY OF

# SENEGAL, THE GAMBIA, AND GUINEA-BISSAU

By Philip M. Mobbs

### Senegal

Production of phosphate rock, fertilizers, and phosphoric acid continued to dominate the mineral industry of Senegal. Minerals accounted for almost 20% of the country's export earnings and approximately 2% of the nation's gross domestic product.

The Government was actively promoting the development of its mineral resources as a viable international investment opportunity (Ministry of Energy, Mines, and Industry, 1995b). Mining legislation in Senegal consisted of the Mining Code, Law No. 88-06, adopted on August 26, 1988. The Petroleum Code was based on Law No. 86-13 of April 14, 1986, with a revision in 1988. The Investment Code, Law No. 87-25 of July 30, 1987, augmented the existing mining legislation. The Government was an equity partner in most current production operations.

An unreported amount of gold, estimated by the Government at 550 kilograms per year, was produced in Senegal by artisanal miners. Development of the Sabodala gold prospect again was delayed. The dispute between Australia's Paget Mining Ltd. and La Source Compagnie Minière over their joint-venture equity interest in the Société Minière de Sabodola (SMS) operating company persisted. Negotiations concerning the development of Sabodola between the joint venture partners, the Government, and Eeximore Afrique of Senegal continued during the year. During 1995, the Government had awarded a permit to Eeximore to develop the surface oxides of SMS' concession. By July 1996, Paget had completed and submitted a development feasibility study. However, during the negotiations, Canarc Resources Corp. of Canada announced that it had been appointed by Eeximore to manage the construction of an open pit mine and carbon-in-leach processing plant at Sabodola (The Northern Miner, 1996).

The Government had approved a number of gold exploration permits. Ashanti Exploration Ltd., a subsidiary of Ashanti Goldfields Corp. (Ghana) Ltd. drilled, mapped, sampled soil and termite mounds, and trenched on the Bambadji prospect to earn interest in the prospect from AGEM Ltd., a subsidiary of International African Mining Gold Corp. of Canada. Leo Shield Exploration NL of Australia obtained an option to acquire interest in the Samborobougou concession. Paget was pursuing an exploration license for the Sounkounkou prospect on the Mako permit. Randgold Resources Ltd., a subsidiary of Randgold & Exploration Ltd. of South Africa, was working on the Souroumdou project. SAMAX Resources Ltd., a subsidiary of SAMAX Gold Inc. of Canada, mapped, sampled, and trenched the Daloto and Toundifara prospects. Secor GeoMin Mining Development Corp., a subsidiary of NovaGold Resources Inc. of Canada, completed a geochemical study of the Bounsankoba project. Anmercosa Mining (West Africa) Ltd., a subsidiary of Anglo American Corp. of South Africa, was engaged in transporting mining equipment from the Dakar entrepôt.

Compagnie Sénégalaise des Phosphates de Taïba (CSPT), which mined calcium phosphate 100 kilometers (km) north east of Dakar, was merged with Industries Chimiques du Sénégal (ICS) during 1996. ICS produced sulfuric acid and phosphoric acid at its Darou Khoudoss fertilizer complex. Société Sénégalaise des Phosphates des Thiès, operating in an area southwest of CSPT, produced aluminum phosphate, attapulgite, and calcium phosphate. *(See table 1.)*

The Government had identified additional deposits of phosphate rock at Matam in northeastern Senegal. However, these deposits, with estimated reserves of 40 million metric tons (Mt), were expected to remain unexploited under current phosphate market conditions. Other mineral resources identified by the Government included clays, copper, diamond, the Tamna Lake diatomite, the Faleme iron ore, peat, silica sands, dimension stone in the southeast, titanium-bearing sands along the coast, and uranium (Ministry of Energy, Mines, and Industry, 1995a).

Tullow Oil Plc. of Ireland and La Société des Pétroles du Sénégal (Petrosen) produced natural gas from the Diam Nadio East Field on the Sebikotane block. The gas was used to power a 20-megawatt turbine at the Cap de Biches power station in Dakar. The joint venture continued exploration of the Sebikotane block during 1996. Petrosen was drilling for gas on the Thiès offshore block. Pecten International Co. of the United States also had exploration rights for an area offshore Senegal.

### The Gambia

The Gambian economy was dominated by agriculture and tourism; there was no significant mineral industry. The Government reported production of 174,012 cubic meters of silica sand in 1996. Clays for bricks, laterite, sand and gravel, and cockle shells were exploited for domestic construction needs. Other identified mineral resources in The Gambia included glass sand deposits and titaniferous sands.

### Guinea-Bissau

After years of small-scale mining activity sustained by domestic demand for construction materials such as laterite and sand, the mineral industry of Guinea-Bissau was swept up in the regional West African exploration frenzy. During 1996, the Ministry of Energy, Industry, and Natural Resources was negotiating exploration concessions for bauxite, gold, and phosphate with American and Canadian companies.

Bauxite had been discovered in the Boé region, approximately 150 km east of Bissau, by N.V. Billiton Maatschappij of the Netherlands during the late 1950's. The U.S.S.R. had studied the deposits in the 1970's and inferred a reserve base of 500 Mt of bauxite with an average grade of 47% $Al_2O_3$ and 5% $SiO_2$. The United Nations Development Programme had begun investigations of the Farim phosphate deposit, approximately 75 km northeast of Bissau, in 1978. The Bureau de Recherches Géologiques et Minières of France studied the deposit from 1981-85, and estimated a resource of 95 Mt averaging 30% $P_2O_5$ and 30% moisture. Mining was regulated by the 1990 Mining Code. Petroleum operations were governed by the 1982 Petroleum law.

In the minerals fuels sector, Monument Oil and Gas Plc. of the United Kingdom (38.75%), Sociedad Internacional Petrolera S.A. of Chile (38.75%), and the state company Empresa Nacional de Pesquisa e Exploracao de Guinea Bissau (22.5%) were working on offshore Block 3.

Development of the bauxite and phosphate deposits had been hampered in the past by the lack of suitable transportation infrastructure. The Government was interested in constructing a deep water terminal on Sao Joao Bay to handle the proposed bauxite exports. The Government was also pursuing the development of an 18-MW-capacity hydroelectric plant at Saltinhoto that would almost double the country's existing 20-MW production capacity.

## References Cited

Ministry of Energy, Mines, and Industry, 1995a, Mineral Resources Development Investment Opportunities: Ministry of Energy, Mines, and Industry, 35 p.

_____, 1995b, Mining Resources in Senegal: Ministry of Energy, Mines, and Industry, Direction des Mines et de la Géologie, 65 p.

The Northern Miner, 1996, Canarc to construct plant in East Senegal: March 11, 1996, p. A1.

## Major Sources of Information

Direction des Mines et de la Géologie
B.P. 1238
Dakar, Senegal
Telephone: (221) 32-07-261
Fax: (221) 32-08-52
The Ministry of Economic Planning and Industrial Development
Central Bank Building
Banjul, The Gambia
The Ministry of Energy, Industry, and Natural Resources
C. P. 399
Bissau, Guinea-Bissau
Telephone: (245) 212-618

TABLE 1
SENEGAL: ESTIMATED PRODUCTION OF MINERAL COMMODITIES 1/

(Thousand metric tons unless otherwise specified)

| Commodity 2/ | | 1992 | 1993 | 1994 | 1995 | 1996 |
|---|---|---|---|---|---|---|
| Cement, hydraulic | metric tons | 601,071 3/ | 589,820 3/ | 590,000 | 590,000 | 590,000 |
| Clays, fuller's earth (attapulgite) | do. | 112,336 3/ | 119,000 3/ | 119,000 | 120,000 | 120,000 |
| Gold | kilograms | 500 | 550 | 550 | 550 | 600 |
| Petroleum: | | | | | | |
| Natural gas | thousand cubic meters | 110,000 | 110,000 | 110,000 | 110,000 | 110,000 |
| Crude oil | thousand 42-gallon barrels | 4 | 4 | 2 | 2 | 2 |
| Refinery products | do. | 4,700 | 6,200 | 6,200 | 2,500 | 2,500 |
| Phosphate rock and related products: | | | | | | |
| Calcium phosphate-based fertilizers | | 169 3/ | 160 3/ | 160 | 160 | 160 |
| Crude rock: | | | | | | |
| Aluminum phosphate 4/ | | 75 | 29 | 29 | 40 | 40 |
| Calcium phosphate | | 2,284 3/ | 1,667 3/ | 1,587 3/ | 1,500 | 1,800 |
| Phosphoric acid | | 288 3/ | 274 3/ | 274 | 274 | 300 |
| Salt | metric tons | 110,000 3/ | 117,400 3/ | 117,000 | 120,000 | 120,000 |

1/ Includes data available through Apr. 15, 1997.

2/ In addition to the commodities listed, Senegal produced clays, sand and gravel, and stone for local construction purposes, and limestone for cement. Information is inadequate to make reliable estimates of output levels.

3/ Reported.

4/ Estimated data, based on aluminum phosphate clinker numbers reported by U.S. State Department, follows, in metric tons: 1992–54,000; 1993–21,000.

### THE MINERAL INDUSTRY OF

# SIERRA LEONE

### By Philip M. Mobbs

Sierra Leone's mineral production remained restricted by civil unrest during most of 1996. The industry's prospects significantly improved when the Government and the Revolutionary United Front (RUF) signed a peace agreement on November 30, 1996. The mineral industry normally generated from 15% to 20% of the gross domestic product, 80% to 90% of export earnings, and employed almost 15% of the labor force, primarily in rural areas. However, the troops of the RUF have disrupted diamond mining operations intermittently since 1992 and in early 1995 the fighting resulted in the suspension of most mineral operations in Sierra Leone. During 1996, a South African security firm continued to assist the Government in maintaining control of the mining areas, allowing diamond and gold recovery to continue. However, operations at the bauxite and titanium minerals operations remained inactive.

The mining law, the Mines and Minerals Decree, (N.P.R.C. Decree No. 5) became effective on March 4, 1994. The Mineral Resources Development Policy (Government Notice No. 105 of March 9, 1995) required that proposals for the rehabilitation of mining sites be submitted and approved by the Ministry of Mineral Resources prior to the commencement of large-scale mining operations. Notice No. 105 also required small miners to assist with the rehabilitation of artisanal sites. During 1996, the Ministry approved 40 Exclusive Prospecting Licenses (EPLs) and 10 Exploration Licenses. Increased international interest was anticipated with the ending of the civil war.

The total value of minerals produced recovered to $32 million[1] in 1996 from $22 million in 1995 (Pas and Wright, 1997). The value of Sierra Leone's mineral exports was reported at $30 million in 1996 compared with $25 million in 1995 and $102 million in 1994. For the last 2 years, diamond has been the nation's principal mineral export, replacing bauxite, ilmenite, and rutile. The Government Gold and Diamond Office was responsible for supervising the export of precious minerals. The Government has estimated that perhaps as much as two-thirds of the artisanal diamond and gold production and subsequent trading activity continued to bypass official revenue-collection channels. *(See table 1.)*

During 1996, Sierra Leone Ore and Metal Co. (SIEROMCO), announced it would not reopen its bauxite operations in the southern Mokanji area (Mining Journal (London), 1996). Prior to being overrun by the RUF insurgents in 1995, SIEROMCO had estimated the production life of the Gbonge deposits to be 10 to 15 years. Jupiter Export-Import Inc. obtained an EPL for the Port Loko bauxite deposit in the northwest.

Diamond production in 1996 was primarily by small-scale artisanal miners. Although recent production was almost entirely from alluvial deposits, international exploration expanded interest to the kimberlite pipes in the Yengema and Tongo regions of eastern Sierra Leone.

The Government assigned the Koidu Kimberlite EPL east of Yengema in the Kono District to Branch Energy Ltd. of the Isle of Man, United Kingdom. Sunshine Kimberlite Mining Co., a subsidiary of Sunshine Mining of the United States, and Diamond Fields Resources of Canada had held rights to the concession. Branch Energy was acquired by Carson Gold Corp. of Canada in October 1996. Carson Gold simultaneously changed its name to DiamondWorks Ltd. DiamondWorks continued work on alluvial EPLs along the Sewa River and at Matemu.

AmCan Minerals Ltd. of Canada acquired the diamond exploration properties of Armsec International (SL) Ltd. and planned to work on a number of sites along the Sewa River. White Swan Resources (UK) Ltd. of the United Kingdom, a subsidiary of White Swan Resources Inc. of Canada, also was acquiring interest in companies holding diamond EPLs along the Sewa River.

Rex Mining Sierra Leone, a subsidiary of Rex Diamond Mining Corp. of Canada, was drilling and bulk sampling on its Tongo Fields kimberlite concession and was preparing to install a washing plant at its Kono District alluvial concession, near Koidu. Gold King Condolidated, Inc. of the United States and Gem World (SL) Ltd. of Sierra Leone were negotiating over a concession in the Kono District.

Offshore, the Diamond Corporation West Africa Ltd., a wholly owned affiliate of De Beers of South Africa, terminated its exploration program in August. The joint venture between Malaysia Mining Corp. Bhd. of Malaysia and Casierra Development Fund Inc. of Canada completed its sampling program on offshore EPL No. 5/94 in June 1996, and in August, the joint venture was dissolved.

Gold was recovered mainly in the streams draining the northern Sula Mountains. Official gold production figures remained low owing to smuggling and the civil war. The Geological Survey of Sierra Leone had identified alluvial gold deposits in the Gori Hills, Kangari Hills, Loko Hills, Nimini Hills, and Sula Mountains. Companies involved in various stages of gold exploration included Afro American Mining; Baomahun Gold Mines; Condolidated Venturex Holdings Ltd. of Canada; General Investigations Development; Golden

---

[1] Where appropriate, values have been converted from Sierra Leone leones to U.S. dollars at the rate of LE900=US$1.00 in 1995 and 1996 and LE578.17=US$1.00 in 1994.

Prospect Mining Co. PLC of the United Kingdom; Golden Leo Resources Ltd., a subsidiary of Mano River Resources of Switzerland; Gondwana Investments; Resources Finance Ltd.; Rex Mining; and Sierra Gold.

The rehabilitation of the 10,000-barrel-per-day capacity Freetown petroleum refinery continued. West African Mining and Refining Co. Ltd., a recently formed subsidiary of Unipetrol Nigeria PLC, owned and operated the refinery.

Resource Securities Ltd., a subsidiary of Golden Prospect Mining Co., and Resources Finance Ltd. were exploring for platinum on the Freetown Peninsula.

The mining facilities of Sierra Rutile Ltd., a 50% Nord Resources Corp. of the United States and 50% Consolidated Rutile Ltd. of Australia joint venture, had been overrun by RUF forces in 1995. The company spent 1996 restructuring its debt and arranging financing for the rehabilitation and expansion of its operations near the Imperri Hills in southern Sierra Leone. Mining is expected to resume by 1998. Time Mineral Research Co. Ltd. had obtained an EPL for ilmenite and rutile in the Mawuru River area.

The port at Freetown received most of the country's imports and all its petroleum import traffic. Ports at Niti and Pepel were operated by private mining firms and normally handled bulk exports of bauxite and rutile.

Sierra Leone has additional mineral deposits, including low-grade chromite, clay, graphite, iron ore, kaolin, lignite, and nepheline syenite. However, inadequate infrastructure, poor resource management, and the recently ended insurgency in the interior have severely hampered development. With a large part of the surface alluvials effectively high-graded by artisanal activity, increasingly deeper strata and undeveloped kimberlites will be targeted by international companies interested in entering the Sierra Leone diamond industry. Diamond production was expected to significantly increase with the number of international firms proposing to start up larger scale operations in 1997. Sierra Leone is expected to return as one of the world's leading rutile producers when Sierra Rutile resumes operations.

## References Cited

Mining Journal (London), 1996, Sierra Rutile reopening depends on funding: Mining Journal (London), v. 327, no. 8399, October 11, 1996, p. 283.

Pas, G., and Wright, L., eds., 1997, Sierra Leone: Freetown, Sierra Leone, Ministry of Mineral Resources, [not paginated].

## Major Source of Information

Ministry of Mineral Resources
Youyi Bldg., Brookfields,
Freetown, Sierra Leone
Telephone: (232) 22-240-420
Fax.: (232) 22-240-574

TABLE 1
SIERRA LEONE: PRODUCTION OF MINERAL COMMODITIES 1/

(Thousand metric tons unless otherwise specified)

| Commodity | | 1992 | 1993 | 1994 | 1995 | 1996 |
|---|---|---|---|---|---|---|
| Aluminum: Bauxite, gross weight | | 1,250 | 1,170 | 735 | -- | -- |
| Diamond | thousand carats | 296 | 158 | 255 | 214 r/ | 270 |
| Gold 2/ | kilograms | 92 | 157 | 125 | 4 | 16 |
| Gypsum e/ | metric tons | 4,000 | 4,000 | 4,000 | 100 r/ | 300 |
| Petroleum refinery products | housand 42-gallon barrels | 1,010 | -- | -- | -- 3/ | -- 3/ |
| Salt e/ | | 200 | 200 | 200 | -- | 50 |
| Titanium: | | | | | | |
| Rutile ore and concentrate 96% $TiO_2$, gross weight | | 149 | 152 | 137 | -- | -- |
| Ilmenite ore and concentrate 60% $TiO_2$, gross weight | | 60 | 63 | 47 | -- | -- |
| Zircon | metric tons | 1,330 | -- | 1,300 | -- | -- |

e/ Estimated. r/ Revised.

1/ Table includes data available through Apr. 30, 1997.

2/ Data includes only officially reported production.

3/ The refinery was reactivated in 1995 for test runs.

## THE MINERAL INDUSTRY OF

# SOUTH AFRICA

### By Thomas P. Dolley and George J. Coakley

The Republic of South Africa remained one of the world's foremost mining and mineral processing nations in 1996. South Africa had the largest production of gold and was the largest or among the dominant producers of many other mineral commodities. The most important mineral commodities produced in South Africa, in terms of value, continued to be gold, coal, and platinum-group metals (PGM). Additionally, world-class output of metallic minerals included ores and/or smelted products of antimony, chromium, iron, manganese, titanium, uranium, vanadium, and zirconium. Important output of industrial minerals included andalusite, asbestos, diamond, dimension stone, fluorspar, phosphate rock, and vermiculite. South Africa was a major producer and the world's third largest exporter of coal. It was also the largest producer of liquid fuels and petrochemicals derived from coal. South Africa's well developed railway and port infrastructure served the domestic minerals industry and those in neighboring countries. Summarizing for the year, South Africa produced about 58 different mineral commodities from over 700 mines and quarries, to include about 50 gold operations, 60 coal mines, and over 60 diamond operations (Mining Journal Ltd., 1997; Verster and van Luitingh, 1997). South Africa's gross domestic product (GDP) in 1996 was about $115 billion, and total exports of all goods were valued at $28 billion[1] (United Nations Monthly Bulletin of Statistics, 1997). Mineral commodities continued to be the cornerstone of the South African economy. According to the South African Chamber of Mines, the mineral industry contributed about 8% to the GDP, or about 15% if the industry's downstream effects are taken into consideration.

Removal of economic sanctions against South Africa in 1994 has led to improved trade relations with a number of countries and opened the doors for more foreign investment by South African mining companies, particularly in other areas of Africa. South African mineral commodities were exported to about 80 countries in 1996. Additionally, the removal of economic sanctions has helped to facilitate foreign investment in South Africa.

Total sales of crude or primary minerals in 1996, as reported by the South African Minerals Bureau, amounted to about $15.2 billion. Export sales of mined and quarried commodities accounted for about $12.1 billion of this, including gold valued at $6.1 billion, coal valued at $1.9 billion, and PGM valued at $1.8 billion (South African Minerals Bureau, 1996). South Africa also had important production of a number of secondary or processed mineral commodities, notably ferroalloys and steel, cement, manufactured fertilizers, and refined petroleum products (from coal and crude petroleum). Almost 90% of South Africa's electricity was generated from coal and about 6% from uranium (U.S. Department of Energy/Energy Information Administration, 1997).

## Government Policies and Programs

The Department of Mineral and Energy Affairs (DMEA), within the Ministry of Mineral and Energy Affairs, was the primary Government entity responsible for oversight of the country's mineral industry. Within DMEA were the Mineral Rights and Management Services Chief Directorate, which was responsible for liaison and information and the registration of mining titles; the Minerals Bureau Directorate, which was responsible for collecting, classifying, and analyzing mineral data; and the Energy Chief Directorate, which promoted the optimum utilization of energy resources. The Government Mining Engineer and the Mining Branch were responsible for mine health and safety issues. Nine Regional Directorates issued prospecting permits, inspected mineral operations and mine rehabilitation sites, and ensured compliance with environmental regulations.

The Council for Mineral Technology (Mintek) and the Council for Scientific and Industrial Research (CSIR) conducted minerals, mineral processing, and environmental research. The former Chamber of Mines Research Organization was incorporated as the Mining Technology arm of the CSIR. The African National Congress Minerals and Energy Policy Centre continued to act as an advisory think tank to the Government.

Mining and minerals policy continued to be under review in 1996, with no amendments to the existing laws by yearend. The mineral industry awaited reforms to the tax system and labor reform (Mining Journal Ltd., 1997). The South African mineral industry operated under substantially the same laws in 1996 as in 1993. These include the Mining Titles Registration Act, 1967; Mining Rights Act, 1967; Central Energy Fund Act, 1977; Petroleum Products Act, 1977; Nuclear Energy Act, 1982; Diamonds Act, 1986; Electricity Act, 1987; Mineral Technology Act, 1989; Minerals Act, 1991; and Minerals Amendment Act, 1993. The Liquid Fuels and Oil Act, 1947, was repealed by the Liquid Fuels and Oil Repeal Act, 1993. Revisions to the Nuclear Energy Act, 1982, as amended in the Nuclear Energy Act, 1993, came into effect during 1994. A number of these laws were expected to be subject to review.

In May 1995, one of the country's worst mining tragedies occurred at Vaal Reefs Gold Mine where 104 men lost their lives due to a locomotive falling down a mine shaft. Pursuant to the accident, the Vaal Reefs Commission of Inquiry suggested several mine safety measures be incorporated into law. The Vaal Reefs Commission highlighted the high illiteracy rate among miners as a problem that needed to be addressed through additional remedial and safety training. As a result, a new Mine and Safety Act was passed in June 1996. Under the new law, mine managers have increased responsibilities for the environmental, health, and safety of the mine and mine labor.

---

[1] Where necessary, values have been converted from South African rands (R) to U.S. dollars at the rate of R4.29=US$1.00 for 1996.

Among Chamber of Mines members, gold mine fatalities dropped to 304 in 1996 from 401 deaths in 1995. Fatalities at gold operations traditionally represent the highest proportion in the South African mining industry. The buildup and release of natural earth stresses associated with deep to ultradeep (1,000 meters (m) to 3,800 m) mining and the related seismic events or rockbursts have been a major cause of fatalities. For example, on November 18, 1996, a 3.1 Richter Scale seismic event occurred at Western Deep Levels' East Mine at a depth of 3,200 m causing 1 fatality with 19 injured. Gold production was not adversely affected.

## Environmental Issues

New mining projects were under increased environmental scrutiny. Reclamation plans and environmental impact statements are required for existing and proposed mineral operations. Emissions were being reduced at the country's smelters. A number of gold mines' tailings piles were being reprocessed. Feasibility studies were underway to install scrubbers at the country's many large coal-fired powerplants, although the cost of such retrofits was expected to be prohibitive. Underground development was being considered for the Gamsburg zinc deposit that could more economically be mined as an open pit. An independent committee recommended against the issuance of a mining permit for the St. Lucia titaniferous sands project in an environmentally sensitive part of the northern Natal coastline, with the Government concurring with this recommendation and denying the permit. A proposed new steel plant for Saldanha Bay was opposed on environmental grounds, but subsequently received approval to proceed. South Africa's steel recycling program had a 51% recovery rate in 1996, third globally after Japan and Germany (U.S. Embassy, 1997a).

According to the South African Minerals Bureau, diamond mining is not as environmentally threatening as the mining of other commodities. Fragile environments can be disturbed however, but larger mining companies, such as De Beers Consolidated Mines (De Beers), utilize technologies to mitigate environmental damage due to diamond mining. Small-scale diamond miners are less able to heed environmental restrictions (Damarupurshad, 1997).

In August 1995, the Department of Environmental Affairs and Tourism initiated a Consultative National Environmental Policy Process, referred to as CANAPE, to review the state of the environment in South Africa and to recommend a new environmental policy for the country. Subsequently, a draft Green Paper was submitted for public discussion and comment in October 1996 (South African Department of Environmental Affairs and Tourism, 1996). CANAPE was to convene another conference to discuss the issues identified in the Green Paper with all relevant parties. An environmental policy White Paper was then to be drafted by the Government and was expected to be submitted for Cabinet and Parliamentary approval by mid-1997.

## Production

South Africa in 1996 was one of the largest and most diverse minerals producers in the world. As shown in table 1, output levels in 1996 were mixed. Gold production has steadily decreased since 1993. In the major metals sector, production of chromite, iron ore, pig iron, and steel decreased, while aluminum, ferrochrome, ferromanganese, and manganese ore saw increases for the year. Among other mineral commodities, output of diamond, silicon ferroalloys, uranium, and vanadium remained static or experienced minor increases in 1996. Output of lead and nickel also experienced minor increases.

In the industrial minerals sector, vermiculite production dropped by up to 10% along with ongoing declines in asbestos production, in step with an ever diminishing world market. Cement production, a useful leading economic indicator, decreased 16% in response to a slowdown in domestic housing starts.

## Trade

The South African Minerals Bureau compiles production, trade, and value data for most crude or primary minerals and for selected processed mineral products. The following data are from the South African Minerals Bureau, unless otherwise indicated.

Exports accounted for about 79% of total primary minerals sales revenues of $15.2 billion in 1996. The $12.1 billion in these primary mineral exports approached 43% of the total value of all exports. The relative contribution of mining to total export revenues has been declining as the manufacturing sector of the economy has expanded over the past 10 years. The South African Minerals Bureau estimated that the inclusion of the various processed mineral products, such as ferroalloys and steel, would raise the contribution of the minerals sector to well over 50% of total export revenues.

Primary mineral exports were led by gold valued at $6.1 billion. Following gold, the most valuable crude mineral exports were coal valued at $1.9 billion and PGM valued at $1.8 billion. The expanded Richards Bay Coal Terminal shipped 60.2 million tons of coal in 1996, maintaining South Africa's position as third largest coal exporter in the world. Other mineral exports, in order by value, were iron ore at $302 million, copper at $165 million, nickel at $151 million, and manganese ore at $125 million. Although individual data were officially withheld, exports of diamond, titanium, and zirconium minerals accounted for most of the $1.2 billion reported by the South African Minerals Bureau as "miscellaneous" mineral exports. Other mineral exports for 1996 were chrome ore valued at $99 million, lead valued at $44 million, and asbestos at $22 million.

In the value-added sector of the mineral industry, 1996 exports of processed mineral products such as chrome alloys and manganese alloys were valued at $563 million and $364 million, respectively. South African steel, including stainless steel, exports were valued at about $1.8 billion in 1996. Major destinations for processed mineral exports in 1995, the last year for which data were available, were Europe at 38.4% by value, the Pacific Rim countries at 37.7%, and North America and Central America at 17.6%. Exports within Africa account for less than 1% of South African mineral export trade. With the end of economic sanctions, South African intraregional trade in Africa is expected to increase although the markets remain comparatively small.

Although South Africa is relatively self-sufficient in the vast majority of its mineral needs, some mineral commodities are imported. In 1995, the last year for which data were available, significant mineral imports by value were diamonds, precious metals, alumina, certain ferroalloys, nickel, coking coal, magnesite, magnesia, and sulfur.

## Structure of the Mineral Industry

The South African minerals and energy industries operates on a free enterprise, market-driven basis. Government involvement in these sectors is minimal and is primarily confined to ownership of the national electric utility, Eskom, and the national oil and gas exploration company, Soekor, including additional subsidies provided to the parastatals, Mossgas and Sasol's synthetic fuels programs. With the end of economic sanctions and freer access to world petroleum supplies, these state-owned energy companies are now being considered for privatization.

In South Africa, the bulk of mineral land holdings and production are controlled by five mining investment houses, Anglo American Corporation (AAC) (including Johannesburg Consolidated Investment Limited (JCI)), Gold Fields of South Africa (GFSA), Gencor Limited (formerly General Mining and Finance Corp.), Rand Gold and Exploration Co, (formerly Rand Mines), and Anglovaal. These houses also had major holdings in most other sectors of the South African economy. The legal and regulatory framework that favored this arrangement was expected to be reevaluated by the new Government. The overall structure and ownership of the minerals industry, as of the end of 1996, is summarized in table 2.

During the year, the major mining houses continued to divest themselves of their nonmining subsidiaries—a process of corporate restructuring, locally referred to as "unbundling." Companies were cognizant of overseas expansion opportunities and black empowerment—a process greatly aided by the removal of economic sanctions against South Africa following the 1994 election victory of the African National Congress. In May 1995, AAC unbundled its holdings in JCI into three separate companies: JCI Limited, with interests in gold, ferrochrome, and coal and base metals; JCI's and AAC's platinum holdings becoming Anglo American Platinum Corp. (Amplats), forming the world's largest PGM producer; and Johnnies Industrial Corp. (Johnnic), containing its nonmining industrial holdings. JCI and Johnnic were placed on the market for purchase by black-owned businesses. A black business group, National Empowerment Consortium, purchased 20% of Johnnic for $325 million. In November 26, 1996, the black-owned Capital Alliance, the financial arm of the African Mining Group, purchased 34.9% of JCI for $610 million (du Plessis, 1996). Additionally, AAC renamed the company's gold and uranium division to Anglogold. Anglovaal Ltd. divided its assets into two new companies in 1996. The first company, Avmin, will manage all of Anglovaal's strategic mineral and mining investments. The second company, Avgold, will manage most of Anglovaal's gold properties and exploration activities. Randgold Resources unbundled the last of its assets in 1996 (Mining Journal, 1996a).

The major mining houses are the principal members of the Chamber of Mines of South Africa. Other Chamber of Mines members included the majority of remaining gold and coal mines and a number of producers of other mineral commodities. The Chamber of Mines was responsible for a variety of advisory and service functions and represents about 85% of the mining interests in South Africa. One of the main activities of the Chamber was the annual wage negotiations between member mines and the National Union of Mineworkers. The Rand Refinery, the largest gold refinery in the world, was affiliated with the Chamber.

The largest foreign-owned mining group operating in South Africa was Rio Tinto Plc. (RTZ) of the United Kingdom, which jointly owned, with AAC, the Palabora copper mine in northeastern Transvaal, one of the largest copper mines in the world. RTZ was also a 50% shareholder in Richards Bay Minerals Ltd. (RBM), a major world producer of mineral sands, with operations in the coastal areas of KwaZulu-Natal Province.

According to the Minerals Bureau, the overall South African mining industry employed an average of 536,475 workers in 1996—down about 59,000 employees from the 1995 level. Employment in the mining industry represented about 3.5% of the country's economically active population. The gold industry was the largest employer within the mining sector with 63.1% of the total employees. Total remuneration paid to the mining workforce in 1996 was 14.5 billion rands, equivalent to $3.4 billion. Employment at Chamber of Mines-controlled gold mines in 1996 dropped to 342,439, down from a peak employment level of 534,255 in 1986.

## Commodity Review

### *Metals*

**Aluminum.**—South Africa has no economically exploitable deposits of bauxite and no alumina production capacity. All alumina feedstock for the production of aluminum metal is imported. Primary aluminum production continued to be entirely by Aluminum South Africa (Pty.) Ltd. (Alusaf) at Richards Bay, including the Bayside smelter and the new Hillside smelter. Production of aluminum metal increased in 1996 to about 70% of Alusaf's total installed aluminum production capacity of 876,000 metric tons per year (t/yr). Alusaf began production from its new $1.5 billion, 466,000-t/yr aluminum smelter at Hillside, adjacent to its Bayside smelter in July 1996. The Hillside project is one of the largest greenfield aluminum smelters ever built. Gencor Ltd., the controlling owner, had signed alumina supply contracts with Alcoa of Australia Ltd. and Billiton to supply 500,000 t/yr for 20 years and 400,000 t/yr for 15 years, respectively. In turn, Alcoa and Billiton would be major consumers of the smelter's output.

Shiploading and unloading facilities at Richards Bay were upgraded in anticipation of an eventual influx of 1.34 million metric tons per year (Mt/yr) of alumina and 200,000-t/yr petroleum coke, compared with current imports of 340,000 t/yr and 30,000 t/yr, respectively.

**Antimony.**—Consolidated Murchison Ltd., is South Africa's only producer of antimony (as stibnite concentrate), with its national output the fourth largest in the world after China, Russia and Bolivia. However, for the last quarter of 1996, Consolidated Murchison reported that revenue declined by 14% owing to the drop in the world price for antimony. The drop in revenue occurred despite an 18% increase in the volume of antimony sold. By yearend 1996, Consolidated Murchison had planned to proceed with an approximately $16 million investment to develop additional ore reserves through its Beta Shaft. However, declining ore grades and difficult mining conditions coupled with funding shortfalls, and the need for the company to show sustained improvement in revenue, have stalled development of the Beta Shaft project. Current mine reserves are expected to be depleted within 6 years at the current combined production rate of 37,000 metric tons (t) of antimony and byproduct gold ore per month. In recent years, most or all of Murchison's concentrates have been sold to the adjacent Antimony Products (Pty.) Ltd. plant for conversion to antimony oxide.

**Chromite.**—Chromite production declined slightly during the year, owing to the uncertain fluctuation of the chrome price on world markets. Production was from more than 20 mines exploiting the Bushveld Ultramafic Complex. About 26% of the ore was exported and the remainder went to supply domestic ferrochrome smelters. Domestic consumption of chromed ore was the highest in the world. Within South Africa, this consumption fed the world's leading ferrochrome industry, as well as a world-class chrome chemicals and refractories industry. Chrome ore sales were valued at $189 million in 1996, of which $99 million was export revenue (South Africa Minerals Bureau, 1996).

Chromecorp. Holdings Ltd., Gencor's Samancor Ltd., and Consolidated Metallurgical Industries (CMI) were the largest chromium producers in the country. In 1996, Chromecorp planned to double output from its Wonderkop furnace complex to 320,000 t/yr. The company was actively developing new ferrochrome markets in Asia. During the year, Samancor had initiated divesting of nonmining assets. CMI increased its annual production capacity from 360,000 t/yr to 430,000 t/yr in 1996 (Mining Journal Ltd., 1997). The South African chromium industry did not promote further export growth of metallurgical ore to feed foreign ferrochrome industries in order to avoid competition with its own substantially vested domestic industry (South Africa Minerals Bureau, 1996).

**Copper.**—The Palabora Mine was by far the largest copper producer in the country. Output of ore from the 80,000-metric-tons-per-day (t/d) mine complex increased slightly and mill output for the year was a record 143,365 t of copper-in-concentrate. Both production of copper cathode, at 104,300 t, and sales were down from that of 1995. The mine also produced baddeleyite, nickel sulfate, uranium oxide, phosphate concentrates, and vermiculite, as well as modest amounts of precious metals contained in refinery tankhouse slimes. Open pit operations were slated for closure in 2002. Thereafter, it was proposed to carry on mining underground. The $349 million Palabora Underground Mining Project was on schedule during the year. Construction of the exploration shaft began at midyear, with work on the production and service shafts to begin in mid-1997. Full production from the underground operations was to occur in 2002, with planned production of 30,000 t/d of copper ore over 20 years (Palabora Mining Company Limited, 1996). Apart from two other copper companies, the metal was produced in small amounts by the country's PGM mines.

**Gold.**—Gold production in South Africa continued to decline in 1996. According to the Chamber of Mines, South Africa s gold industry had its lowest level of output since 1956. South Africa's share of global gold production for the year was about 21%, the country's lowest percentage since 1903. However, South Africa remained the global leader in gold production. The factors accounting for South Africa's declining gold production were numerous and synergistic in their effects. Restructuring and streamlining of the South African gold industry, increased mining costs, mine labor unrest, and declining ore grades were all major factors contributing to decreased gold output. Starting in 1994, an additional factor was the increase in public holidays and concomitant decreases in the average number of work shifts for miners. These issues remained largely unresolved as of yearend (Chamber of Mines of South Africa, 1997; Mining Journal Ltd., 1997).

An important contribution to the fall in gold output was declining ore grades. For members of the Chamber of Mines, the average grade of ore milled in 1996 was 4.91 grams per metric ton (g/t) gold. Though this was a 0.04 g/t increase from that of 1995; there has been a general grade decline totaling about 60% from the late 1960's.

Working costs for the gold industry slowed from the meteoric increases typical of prior years. For Chamber members, working costs (in rands) in 1996 rose almost 12% per metric ton of ore milled and 8% per kilogram (kg) of gold recovered. Increases reflected generally high inflation levels (including higher wages) and, notwithstanding labor-intensive mining methods, the great technical difficulties of mining at extreme depths. Total working profit for Chamber members increased by about 48% to about $1.2 billion in 1996. According to the Chamber of Mines, containment in working costs and the devaluation of the rand against the U.S. dollar contributed to the improvement in revenue. The number of mines in a marginal position dropped from 15 mines in 1995 to 7 mines in 1996, owing to increased profits among most gold mines. Continuing to mitigate cost increases was the fact that costs were denominated in rands and gold sales were in dollars.

Traditionally, at times of low gold prices, South African producers have concentrated on mining their higher grade reserves and exploited lower grade material only when prices improved. With relatively stagnant and/or low gold prices since the mid-1980's, there has been rapid depletion of relatively high-grade ores at most mines. This has led to the industry becoming cognizant of mining methods that would render remaining low-grade resources uneconomic. Particularly vulnerable were very deep resources and those very distant to the ore-hoisting shafts—the latter problem sometimes has been overcome by merging adjacent mines.

The continued unbundling of assets by major South African mining companies, discussed earlier in the Structure of the Mineral Industry section, was the main highlight for the gold industry during the year. Utilization of new technologies to mine increasingly deeper gold reserves also highlighted the year. Anglogold planned to launch new deep to ultradeep mining (2,000 to 5,000 m deep) technology to access Ultra Deep Levels gold reserves to the south of the company's Elandsrand property. Anglogold's new technology would allow the sinking of two mine shafts on the property to levels 3,400 to 5,000 m deep. The cost for each shaft complex would be about $1.2 billion each (Mining Journal Ltd., 1997).

JCI initiated two important projects during the year. In July 1996, the company announced plans to proceed with infrastructure development for the exploitation of the South Reef at Randfontein's Doornkop Shaft (JCI Ltd., 1996). The second project was at JCI's HJ Joel gold mine, which began sinking operations of the No. 1 shaft in August 1996. The shaft will be constructed to a depth of 1,673 m, with commissioning of the structure in the year 2001. Estimated cost for the shaft construction is $302 million. Profits at HJ Joel were expected to improve with the initiation of new mining methods and equipment upgrades. The construction of the new No. 1 shaft was to be funded from revenues from current operations. Management at HJ Joel had considered forward selling of gold production through the year 2001 to finance the shaft project. This forward selling concept, termed "hedging," was abandoned owing to a volatile currency market. Various other South African gold producers have considered hedging, but have also been dissuaded by market volatility (Mining Journal, 1996b).

At yearend, Randgold announced that it would proceed with development of a commercial-scale gold refinery to be built at the Harmony Mine. This follows Randgold and Mintek's successful development and testing of a pilot plant. The refinery will use a solvent extraction process for the chemical refining of gold to 99.99% purity. Mintek will design, construct, and commission the 2-metric-ton-per-month gold plant slated for completion in 1997. Randgold expected that a local gold jewelry industry may be developed at the site (U.S. Embassy, 1996b).

Gold theft and smuggling continued to plague the South African industry during the year. The estimated loss of revenue from gold smuggling was $350 million per year (The Mail & Guardian, 1996).

**Iron and Steel.**—Iron Ore.—Iron ore production in South Africa declined slightly in 1996, owing to bottlenecking and capacity constraints on the 861-kilometer (km) railway line from Iscor Ltd.'s (Iscor) Sishen Mine to the port at Saldanha Bay. Two primary types of iron ore are produced in South Africa, hematite and magnetite, with production for the year at about 28.8 Mt and 2.1 Mt, respectively. Iron ore exports, primarily hematite, amounted to about 19.3 Mt, worth about $287 million (U.S. Embassy, 1997a; South Africa Minerals Bureau, 1996).

Iscor was South Africa's largest iron ore producer—its two iron mines, Sishen and Thabazimbi—accounted for about 81% of the country's total output. For the year, the Sishen Mine produced 23 million metric tons (Mt) of ore and the Thabazimbi Mine produced 2.5 Mt of ore. Sishen contains about one-half the world's known reserves of lumpy iron ore, grading 65% iron. Iscor plans to increase output at Sishen to 32 Mt/yr by replacing the present 6-day workweek with a 7-day workweek. Iron ore grades from the Thabazimbi Mine are about 60%. Iscor was reviewing mining operations at Thabazimbi and is considering the possibility of conversion to a calcite mine at the end of the mine's predicted 12 to 18 year iron ore mining life (U.S. Embassy, 1997a; South Africa Minerals Bureau, 1996).

Increasing the railing capacity along the route from the Sishen Mine to the port at Saldanha Bay from 18 Mt to 32 Mt was under consideration. Stakeholders in the railway include Orex, a transportation subsidiary of Spoornet; Portnet; and the mining companies Iscor and Associated Manganese. A feasibility study for the railway upgrade was to be discussed by the stakeholders in 1997 (U.S. Embassy, 1997b; South Africa Minerals Bureau, 1996).

The other major iron mine in South Africa was Highveld Steel and Vanadium Corp. Ltd.'s (Highveld) Mapochs Mine. Production of magnetite from the Mapochs Mine was slightly more than 2 Mt for 1996, a decline from that of 1995 (U.S. Embassy, 1997b; South African Minerals Bureau, 1996).

Steel.—South African crude steel production dropped by about 6% from the production level of 1995. Iscor's production dropped, but still accounted for over 86% of the country's total South African crude steel production; the company remained the largest steelmaker in Africa. Iscor indicated that construction on its new steel plant at Saldanha Bay was 40% complete by yearend. The plant would have production capacity of 1.25 Mt/yr of hot rolled coil steel and would be South Africa's first export-focused steel plant. Commissioning of the plant is scheduled for 1998. The plant would use iron ore (pellets) instead of scrap and, while initial feed would be imported, the plant eventually would be supplied from the Sishen Mine. The other major steel producer in South Africa, Highveld, suffered production declines during the year, owing to a labor strike in November 1996.

During the year, a variety of expansion projects were underway in South Africa's stainless steel sector. By 1998, the total planned production capacity of 1.15 Mt/yr for stainless steel in South Africa should solidify the country's place as a major global player in the industry. The installed capacity would account for about 7.5% of global stainless steel production of 16 Mt/yr (U.S. Embassy, 1997b).

Commencing production in February 1996, the new Columbus Stainless Steel plant produced 314,000 t of slab steel and 121,400 t of plate, cold rolled coil, and sheet in 1996. The plant, a joint venture among Samancor, Highveld, and the Investment Development Corporation of South Africa (IDC) (33.3% each), will eventually have a total capacity of 550,000 t/yr of stainless steel, predominantly for export. Production at full capacity had not as yet been achieved, due in part to technical problems at the plant. Target production for 1997 at Columbus was 480,000 t (U.S. Embassy, 1997b).

Iscor's conversion of its Pretoria steel plant to stainless steel output was completed during the year, with a design capacity of 400,000 t/yr of flat-rolled products. Additionally, the company's conversion of its Durban plant to a stainless steel micromill was complete and opened in September 1996. Production capacity of about 100,000 t/yr stainless steel long products was anticipated. The mill was the only stainless steel long-product producer in Africa.

Ferroalloys.—Ferrochrome.—South African ferrochromium production increased during the year to about 1.4 Mt with a total sales value of $614 million. Total export volume for South African ferrochrome exceeded 1.3 Mt in 1996, valued at $563 million. Additionally, local sales and production of ferrochrome have increased substantially in recent years to supply the growing domestic stainless steel industry. South Africa's production of ferrochrome represented 36% of the world total in 1996. Installed production capacity for South African ferrochrome exceeds 2.5 Mt (South Africa Minerals Bureau, 1996).

Ferromanganese.—South Africa's production of ferromanganese alloys grew to 842,000 t in 1996, with 661,000 t of the total being exported. Total sales value for ferromanganese increased to $415 million during the year, of which $364 million were export earnings. New production capacity for South African ferromanganese had been commissioned and was scheduled for startup in 1998, the first such major investment in the industry since 1980 (Armitage and Bates, 1997).

**Nickel.**—South Africa's nickel output is mostly a byproduct of PGM production, with some byproduct production from the Palabora copper mine. Output increased marginally in 1996. With the anticipated growth in demand from stainless steel producers in South Africa and worldwide, Anglovaal in conjunction with AAC speeded its evaluation of its Slaaihoek nickel-cobalt-copper-PGM project. The deposit is hosted by the Uitkomst Mafic Complex near Barberton in the Eastern Transvaal. Anglovaal reported that initial feasibility studies have been positive and during the year the company decided to start early exploitation of a portion of the deposit. A new vertical shaft was drilled to access the Massive Sulphide Body (MSB) of the mafic complex with initial production at the MSB of 36,000 t/yr of concentrate to commence in 1997 (Anglovaal Limited, 1996).

**Platinum-Group Metals (PGM).**—South Africa continued to be the world's largest primary producer of PGM and had almost 90% of world reserves. Production of PGM increased in 1996, maintaining an upward trend over the last 4 years. During the year, South Africa produced approximately 70% of total world PGM supply. Lower prices for PGM coupled with increased global demand for these metals resulted in sales revenues valued at about $1.8 billion—virtually all reported as exports. Included within total PGM in table 1 are the other important byproduct metals, palladium and rhodium. During the year, South Africa produced approximately 25% of global palladium supply and about 75% of global rhodium supply (Chamber of Mines of South Africa, 1997; South African Minerals Bureau, 1996). Production of PGM in South Africa originates almost exclusively from mines of the Bushveld Ultramafic Complex, north of Pretoria (Mining Journal Ltd., 1997). In South Africa, Rustenburg Platinum Holdings Limited (RPH), with controlling ownership by AAC and Amplats, is the largest platinum producer in the world. The other dominant platinum producer is Gencor's Impala Platinum (Implats), the second largest platinum producer in the world.

Several controversies resonated throughout the South African platinum industry during the year. A possible merger of Implats with Lonrho's Eastern and Western Platinum mines was thwarted during the year by the European Commission (EC). The EC cited the problematic creation of a duopoly as a reason for the preventative measure. Implats was also in litigation with the Bafokeng Tribe over the Tribe's desire for increased royalty payments from Implats. Implats currently mines most of its PGM on lands owned by the Bafokeng Tribe. The issue remained unresolved in 1996 (Gencor Limited, 1996; Mining Journal Ltd., 1997). Additionally, Implats was beset by labor strikes during the year and experienced a furnace collapse. The furnace, normally accounting for approximately 80% of Implats production, took 6 weeks to repair (U.S. Embassy, 1996a). RPH's mining operations were affected by a labor strike between June and August 1996. The strike, involving about 19,000 employees, resulted in a production loss of over 2,800 kg of refined platinum (Mining Journal Ltd., 1997).

Beset by labor unrest during the year, GFSA's Northam platinum mine appeared to be overcoming ongoing technical and grade-control problems. The Northam platinum mine is the deepest and hottest temperature platinum mine in the world. The company cited revised mine planning, improved understanding of Merensky Reef geology, and the utilization of hydropower technology as reasons for the mine's improved financial performance in 1996. By December 1996, the Northam Mine had achieved its targeted production rate of 150,000 metric tons per month of ore (Gold Fields of South Africa Limited, 1996). For the year, Implats reported that the company's Enhanced Precious Metals Refinery project was on schedule and within budget (Gencor Limited, 1996).

**Titanium and Zirconium.**—Richard Bay Minerals' Tisand (Pty.) Ltd. (RBM), owned jointly by Gencor and RTZ, produced ilmenite, rutile, and zircon from beach sands north of Richards Bay. A sister company, Richards Bay Iron and Titanium (Pty.) Ltd. produced an 85% titanium dioxide slag from ilmenite concentrates at the Richards Bay smelter, as well as low-manganese pig iron. RBM was the largest titanium mineral producer in the country. Titaniferous magnetite also was recovered at the Phalaborwa carbonatite as a byproduct of copper and phosphate rock production, and titaniferous slag was produced with magnetite ores from the Mapochs Mine by the Highveld steel plant.

During the year, titanium slag produced reached about 1 Mt, with 50,000 t of the latter processed domestically, the remaining 950,000 t was exported. Export destinations were mainly the United States, Europe, and Asia (Mining Journal Ltd., 1997).

Proposals by RBM to mine the large titaniferous sands resources at St. Lucia, north of Richards Bay in KwaZulu-Natal, came under increasing pressure from South African and international environmental groups. These groups offered alternatives to mining the area, notably, a proposal to establish the sensitive ecosystem as a World Heritage site. In a ruling in early 1996 the Government denied the mining permit.

In 1996, AAC's Namakwa Sands project experienced technical problems with the production circuit, including a titanium slag furnace breakdown in November. As a result, production of titanium slag was only 50,000 t during the year. Subsequently, the company reported that the technical problems had been overcome (Mining Journal Ltd., 1997).

Iscor announced that it was conducting environmental impact assessments for its heavy minerals project in the Northern Province, to include the mining area and central processing complex in KwaZulu-Natal. The company reported that the final Impact Assessment Report was being prepared (Iscor Limited, 1996).

Zirconium is produced as a zircon byproduct of Richards Bay and Namakwa Sands mineral sands mining. Palabora Mining Co. Ltd. produces 70% of the world's baddeleyite, which is a zirconium sulfate mineral used in specialized applications in the refractory, ceramics, tanning industries, and in kidney dialysis machines. During the year, the Palabora Mining Co. Ltd. decided to proceed with plans to produce zirconium basic sulfate (ZBS) from zircon sands. The ZBS project, at an estimated cost of $14 million, was on schedule with production to commence in August 1997. Full production capacity was expected to be at 7,895 t/yr, containing 38% $ZrO_2$ by 1999 (Palabora Mining Company Limited, 1996).

**Uranium.**—Uranium production, largely a coproduct of a three Witwatersrand gold mines, showed a slight increase in 1996. Approximately 100,000 kg of uranium oxide was also produced by the Palabora copper mine.

**Vanadium.**—Vanadium was produced from titaniferous magnetite mined from the Bushveld Ultramafic Complex. Output of vanadium declined slightly in 1996. The largest producer was Highveld Steel and Vanadium Corp. Highveld's main products were vanadium slag and vanadium pentoxide flake, although modest amounts of vanadium trioxide also was produced, as was a small amount of ferrovanadium. Rhombus Exploration (Rhoex) was the other major South African producer of vanadium. During the year, Switzerland's Glencore International purchased an 80% stake in Rhoex and acquired 100% ownership of Vantech of South Africa. These actions have fueled speculation that Glencore International may merge these acquisitions in 1997, resulting in control of about one-third of South Africa's vanadium export market (Mining Journal Ltd., 1997).

### *Industrial Minerals*

The value of total sales of industrial minerals produced in South Africa was about $791 million for 1996. Approximately 69% of those sales were on the domestic market. In terms of sales, the three dominant industrial mineral commodities were aggregate and sand, limestone and dolomite, and phosphate rock. The largest domestic consumers of South Africa's industrial minerals were the building and construction sectors, metallurgical sectors, and agricultural sectors (Botha, Verster, and Munzhelele, 1997).

**Cement.**—Cement was produced by Pretoria Portland Cement Co. Ltd., Alpha Ltd., and Blue Circle Cement (Pty.) Ltd. The three companies had equal interest in Natal Portland Cement Co. (Pty.) Ltd., which served much of the Natal market. These companies comprised a cartel, the South African Cement Producers Association (SACPA). In 1995, following a 2-year investigation of the cartel's pricing and supply practices, the South African Competition Board recommended that the cartel be disbanded. Subsequently, SACPA was disbanded in September 1996. It was unclear what the effect of disbanding would be, but the producers were planning to increase output capacity in anticipation of major housing projects sponsored by the new Government.

**Diamond.**—South Africa's rough diamond production increased slightly in 1996. As in years past, De Beers dominated the sector with more than 94% of total production. According to the South Africa Minerals Bureau, of the total of 66 officially permitted diamond mines in South Africa, 49 produced diamonds during the year. Total production by De Beers increased to 9.39 million carats, up by 336,036 carats from that of 1995. Much of the De Beer's increase was from the Venetia, Finsch, and Namaqualand Mines. The increases were notwithstanding De Beers imposing production quotas on its operations, to thwart sales of Russian diamonds outside the auspices of De Beers' Central Selling Organization. The sector contributions to diamond production for the year were as follows: kimberlite diamond production at 8.86 million carats, alluvial diamond production at 1.03 million carats, and marine diamond production at 51,669 carats (Damarupurshad, 1996).

De Beers' future expansion plans centered on increasing operational depths at its existing South African underground mines, to include reopening older workings, in an effort to extend mine life and create jobs. Additional expansion options included streamlining mining processing operations, and increasing the number of shifts at the mines (Mining Journal Ltd., 1997).

### *Mineral Fuels*

Except for a minor amount of gas condensate, South Africa produced no crude petroleum during the year, and only a limited amount of natural gas. Most of the country's primary energy needs were supplied by coal; most electricity was generated by coal-fired power stations, and coal was also the raw material for South Africa's production of synthetic fuels. The Southern Oil Exploration Co. (Soekor), the state-owned petroleum exploration company, controlled all offshore oil and gas prospects.

To date, onshore hydrocarbon discoveries were insufficient and uneconomic. Soekor was to bring on-stream South Africa's first offshore oilfield development by mid-1997. Soekor estimated that the offshore Oribi Field, 140 km southwest of Mossel Bay, had reserves of 20 million barrels of crude oil, and had targeted a production of 20,000 barrels per day (bbl/d) from two wells (Knott, 1997).

South Africa's total throughput refining capacity for crude oil was 465,000 bbl/d from four refineries. As of yearend 1996, South Africa consumes about 450,000 bbl/d of liquid hydrocarbons, of which about 255,000 bbl/d are imported. The remaining 195,000 bbl/d that are consumed were synfuels produced from coal and natural gas (Knott, 1997).

South Africa's synfuels program has been in place for many years. Owing to the comparatively high cost of synfuels compared with conventional crude oil products, the Government emplaced various tariffs and controls on the petroleum marketing sector. It was generally agreed by industry observers that the South African energy industry and tariff system was in need of restructuring and/or privatization. (Knott, 1997).

**Coal.**—South Africa remained the fifth largest coal-producing country in the world and the third largest coal exporter. After gold, coal was South Africa's second largest export. Coal exports were 60.2 Mt, valued at $1.9 billion were shipped, primarily through the Richards Bay Coal Terminal (RBCT). South Africa was the world's largest steam coal exporter after Australia. Total steam coal exports for 1996 represent 21% of the global total or 55.8 Mt. Bituminous coal accounted for more than 98% of South African production. Of the 146.4 Mt of coal consumed domestically, 73.2 Mt went to the electricity sector, 55.6 Mt to the industrial sector, 5.8 Mt for metallurgical purposes, and 5.8 Mt for small consumers (Chamber of Mines of South Africa, 1996).

Three companies, Ingwe Coal Corp., Anglo American Coal Corp. Ltd., and Sasol Mining (Pty.) Ltd. (Sasol), continued to account for more than 80% of the country's coal production. Ingwe was formed through the merger of Trans-Natal Coal Corp. Ltd. and Randcoal in 1994. Other producers included Iscor Ltd., which mined coal for its own internal use. There were numerous independent medium to small coal companies. Although the 76 coal operations within the 19 coalfields of South Africa were spread over an area of 300,000 square kilometers, the main coal-producing area was the Witbank Basin, which accounted for approximately 42% of the country's output. About 65% of the coal was produced from underground mining operations, with the remainder coming from open pit mines. Most open pit mines were less than 70 m deep.

**Synfuels.**—Total throughput production capacity for synfuels in South Africa was about 195,000 bbl/d. The Government was considering plans to privatize the costly $4 billion, Mossgas oil-from-gas project, and Sasol's plants producing oil and petrochemicals from coal. These companies' fuel production was considered too expensive in light of ready access to imported fuels occasioned by the removal of economic sanctions against South Africa. The Government was also reducing the tariff subsidies available to Sasol. The basis for subsidies for synthetic fuels was reduced to a floor price of $18 per barrel of petroleum in 1996, with the subsidy to be phased out entirely by July 1999 (Knott, 1997).

## Reserves

South Africa's mineral reserves are large and diverse and reflect the country's complex geology. A detailed account of the geology of many of South Africa's ore deposits are available from the Geological Society of South Africa and a useful background geologic summary is given in Mining Magazine (Anhaeusser and Maske, 1986; Mining Magazine, 1995). The bulk of South Africa's mineral production is from the northern half of the country. Table 3 gives the reserve base for a number of South Africa's major minerals; diamond reserve data are unavailable. Although data are incomplete for the world, for many of the minerals shown, South Africa's reserves appear to rank among the top five countries and would rank first in the world for andalusite, chromite, gold, manganese, PGM, and vanadium.

## Infrastructure

The country has a well developed and extensive road and railroad infrastructure, serving not only South Africa but also the surrounding region. Roadways totaled 182,329 km of which 55,428 km were paved. Railroad infrastructure totaled 21,431 km of which 9,087 km was electrified (CIA World Factbook, 1996).

A number of ports handled minerals, notably Cape Town, Durban, Richards Bay, Port Elizabeth, Mossel Bay, East London, and Saldanha Bay. In addition to fulfilling the requirements of South Africa itself, the country's ports also served as outlets for landlocked countries such as Botswana, Lesotho, Swaziland, Zambia, and Zimbabwe. South Africa was also a regional supplier of electricity and petroleum products, two of a number of examples of the dependence of neighboring countries on South Africa's infrastructure and transportation networks.

Richards Bay handled the greatest volume of cargo among South African ports. The RBCT had a coal export capacity of about 60 Mt/yr. Coal exports through Durban were only a fraction of those through RBCT. Durban's port facilities were designed mainly for small consignments of high-quality lump bituminous coal and anthracite that cannot be properly handled at Richards Bay.

South Africa continued to maintain reserve stocks of crude oil to counter possible interruptions in imports. The size of the these reserves has been decreased since 1991 to the current 45 million barrels. Storage areas for the reserves are at tank farms at Saldanha Bay and abandoned gold mines in the Ogies area.

South Africa's national electrical power utility, Eskom, had a nominal capacity of 38,497 megawatts, predominantly from coal-fired sources, with a small percentage of electricity being generated from nuclear sources. Total electrical power produced by Eskom in 1996 was 165,370 gigawatt-hours of electricity (Eskom, 1997).

## Outlook

Significant labor issues, such as housing of migrant workers, wages, job training, and work schedules, will likely continue into 1997. Improving mine safety coupled with trade unions demanding a greater say in mining practices will remain important issues for the mining industry. Wildcat strikes and other labor disturbances were ongoing in 1996. The unresolved matters of balancing new holidays with the industry's requested elimination of the ban on Sunday mining, reform of mining rights, and the tax structure were additional unresolved issues.

Increased attention was expected to be given to environmental issues, which also would be factors in projects requiring financing from international lending institutions. The major mining houses will likely continue to increase their holdings and activities overseas, including the forming of strategic alliances with major overseas customers.

The Chamber of Mines expected no further declines in gold production with a stabilization at 500,000 kg for 1997 (Mining Journal Ltd., 1997). For 1997, the Minerals Bureau predicted that total ferrochrome sales would exceed $900 million (South African Minerals Bureau, 1996). The Minerals Bureau also has forecast a rise in industrial minerals export earnings through the turn of the century. This forecast is based on the anticipated continuing depreciation in the exchange rate of the rand against the dollar and strong growth in export volumes of fluorspar, granite, phosphate rock, phosphoric acid export earnings, and vermiculite. This projection would be relatively unaffected by the anticipated drop in export earnings for asbestos (South African Minerals Bureau, 1996).

South Africa appeared to be entering a phase of rapid expansion of value-added mineral processing capacity, especially for metals. In this regard, if labor and energy costs remained low and world markets remained buoyant, South Africa had the potential to greatly increase its market share for many commodities.

## References Cited

Anglovaal Limited, 1996, Annual report, Johannesburg, 68 p.

Anhaeusser, C. R., and Maske, eds., 1986, Mineral deposits of Southern Africa, v. I and II: The Geological Society of South Africa, 2355 p.

Armitage, W. K., and Bates, E. S., 1997, Ferrous minerals and their ferroalloys—1980-1996: South African Minerals Bureau MB Bulletin, v. 10, no. 2, November, 11 p.

Botha, J. C., Verster, J. J., and Munzhelele, N. N., 1997, The performance of South Africa's industrial minerals sector in 1996: South African Minerals Bureau MB Bulletin, v. 10, no. 2, November, 2 p.

Chamber of Mines of South Africa, 1997, South African Mining Industry Statistical tables 1996: Chamber of Mines of South Africa, 42 p.

CIA World Factbook, 1996, [Untitled]: (Accessed January 28, 1998, on the World Wide Web at URL http://www.odci.gov/cia/publications/nsolo/factbook/sf.htm).

Damarupurshad, 1997, The environmental impact of diamond mining: South African Minerals Bureau MB Bulletin, v. 10, no. 2, November, 4 p.

———1996, Diamonds: South African Minerals Bureau MB Bulletin, v. 9, no. 4, July, 7 p.

du Plessis, A. J., 1996, Paper presented at The 102nd Annual Northwest Mining Association Convention, December 4, Spokane, Washington, U.S.A.: Chamber of Mines of South Africa, 7 p.

Eskom, 1997, [Untitled]:(Accessed January 26, 1998, on the World Wide Web at URL http://www.eskom.co.za/graphics/annual/stats.htm).

Gencor Limited, 1996, Annual report: Johannesburg, 108 p.

Gold Fields of South Africa Limited, 1996, Annual report: Johannesburg, 58 p. Iscor Limited, 1996, Annual report: Pretoria, 72 p.

JCI Ltd., 1996, [Untitled]: JCI Ltd. press release. (Accessed July 23, 1996, on the World Wide Web at URL http://www.jci.co.za/).

Knott, David, 1997, Synthetic fuels aiding South Africa to advance its world energy role: Oil & Gas Journal, v. 95, no. 11, March 17, 5 p.

The Mail & Guardian, 1996, Africa's $80-million a year Bullion Smugglers: 2 p. (Accessed October 29, 1996, on the World Wide Web at URL http://www.afnews.org/...press.80038970993.html).

Mining Journal, 1996a, Rand Mines' final tranche: Mining Journal [London], August 30, 1996, p. 171.

———1996b, [Untitled], Mining Journal [London], August 30, p. 174.

Mining Journal Ltd., 1997, Mining annual review—1997: Mining Journal Ltd., 4 p.

Mining Magazine, 1995, The SA Mineral Industry-1—The geological background: Mining Magazine, v. 172, no. 5, (special section) p. 6-9.

Palabora Mining Company Limited, 1996, Annual report: Sandton, 40 p.

South African Department of Environmental Affairs and Tourism, 1996, draft Mineral Policy Green Paper. (Accessed November 4, 1997 on the World Wide Web at URL http://www.bullion.org.za/policy/discuss.htm).

South African Minerals Bureau, 1996, Mineral production and sales Statistics, monthly.

United Nations Monthly Bulletin of Statistics, October 1997, [Untitled]: United Nations Monthly Bulletin of Statistics, v. LI, no. 10, p. 105.

U.S. Department of Energy/Energy Information Administration, 1997, South Africa: 1997. (Accessed November 12, 1997, on the World Wide Web at URL http://www.eia.doe.gov/emeu/cabs/safrica.html).

U.S. Embassy, Pretoria, South Africa, 1996a, Mineral highlights: U.S. State Department Telegram 0323, (March 13, 1996), 32 p.

———1996b, Mineral highlights: U.S. State Department Telegram 007007, (July 23, 1996), 1 p.

———1997a, South Africa's iron and steel industry—Part I: U.S. State Department Telegram 003513, (April 21, 1997), 13 p.

———1997b, South Africa's iron and steel industry—Part II: U.S. State Department Telegram 003515, (April 21, 1997), 11 p.

Verster, J. J., and van Luitingh, 1997, SA's mineral role within the SADC: Mining Magazine, v. 177, no. 1, July, p. 48.

## Major Sources of Information

Chamber of Mines of South Africa
P.O. Box 61809
2107 Marshallton, South Africa
Telephone: (27) 11 838-8211
Fax: (27) 11 834-1884
Internet site: http://www.bullion.org.za
Council for Geosciences (Geological Survey)
Private Bag X112
0001 Pretoria, South Africa
Telephone: (27) 12 841-1911
Fax: (27) 12 841-1203 or 1221
Internet site: http://www.geoscience.org.za
Department of Mineral and Energy Affairs
Government Mining Engineer
Private Bag X59
0001 Pretoria, South Africa
Telephone: (27) 12 322-8561
Fax: (27) 12 322-3416
Minerals Bureau
Private Bag X4
2017 Braamfontein, South Africa
Telephone: (27) 11 339-4414
Fax: (27) 11 403-2061
Internet site: http://www.vigen.com.au/publications.htm
Department of Trade and Industry
Private Bag X274
0001 Pretoria, South Africa
Telephone: (27) 12 3322-7677
Fax: (27) 12 322-7851
Internet site: http://www.sacs.org.za/level3/ministry.htm
Embassy of South Africa
Minerals and Energy Liaison Office
3051 Massachusetts Ave., NW
Washington, DC 20008
Telephone: (202) 232-4400
Fax: (202) 232-3402
Industrial Development Corp. of South Africa Ltd.
P.O. Box 784055

2146 Sandton, South Africa
Telephone: (27) 11 883-1600
Fax: (27) 11 883-1655
Minerals and Energy Policy Centre
76 Juta Street, 9th Floor
2050 Braamfontein, South Africa
Telephone: (27)-11-403-8013
Fax: (27)-11-403-8023
Mintek (Council for Mineral Technology)
Private Bag X3015
2125 Randburg, South Africa
Telephone: (27) 11 709-4111
Fax: (27) 11 793-2413 or 709-4326
Internet site: http://www.mintek.ac.za
National Union of Mineworkers
P.O. Box 2424
2000 Johannesburg, South Africa
Telephone: (27)-11-833-7012
Fax: (27)-11-836-0201
Internet: http://www.anc.org.za/num

**Major Publications**

Chamber of Mines of South Africa:
Annual Report.
Statistical Tables 1996.
Dept. of Mineral and Energy Affairs: Annual Report.
Eskom: Statistical Yearbook.
Minerals Bureau:
South Africa's Mineral Industry 1996.
Operating mines and quarries and mineral processing plants in the Republic of South Africa: various periodic directories.
Mineral Production and Sales Statistics, monthly.

## TABLE 1
## SOUTH AFRICA: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

| Commodity | | 1992 | 1993 | 1994 | 1995 | 1996 |
|---|---|---|---|---|---|---|
| METALS | | | | | | |
| Aluminum metal, primary | | 172,795 | 174,700 | 172,111 | 195,292 | 617,000 |
| Antimony concentrate: 2/ | | | | | | |
| Gross weight e/ | | 6,465 3/ | 7,182 3/ | 7,800 | 9,550 | 8,860 |
| Sb content | | 3,779 | 4,111 | 4,534 | 5,537 | 5,137 |
| Cadmium, Cd content of cadmium cake | | 60 | 70 e/ | -- | -- | -- |
| Chromite, gross weight: | | | | | | |
| More than 48% chromic oxide | thousand tons | 18 | 4 | -- | 16 | -- |
| 44% to 48% chromic oxide | do. | 1,904 | 1,808 | 1,612 | 1,792 | 1,862 |
| Less than 44% chromic oxide | do. | 1,441 | 1,014 | 2,030 | 3,296 | 3,155 |
| Total 4/ | do. | 3,363 | 2,827 | 3,642 | 5,104 | 5,017 |
| Cobalt: | | | | | | |
| Mine output, Co content | | 343 | 265 | 358 | 288 | 350 |
| Refinery output: | | | | | | |
| Metal, powder | | 65 | 71 r/ | 44 r/ | 32 3/ | 42 e/ |
| Sulfate, contained cobalt | | 169 r/ | 172 r/ | 214 r/ | 158 3/ | 200 e/ |
| Total | | 234 | 243 r/ | 258 r/ | 190 | 242 |
| Columbium and tantalum: Columbite-tantalite concentrate: | | | | | | |
| Gross weight | kilograms | 31 | -- | -- | -- | -- |
| Cb content e/ | do. | 11 | -- | -- | -- | -- |
| Ta content e/ | do. | 9 | -- | -- | -- | -- |
| Copper: | | | | | | |
| Mine (company output), Cu content | | 176,074 | 166,348 | 165,213 | 165,573 | 152,595 |
| Metal: | | | | | | |
| Smelter | | 158,700 | 156,600 | 154,700 | 151,200 | 141,730 |
| Refined, primary | | 120,100 | 127,900 | 129,600 | 124,300 | 116,000 |
| Gold, primary | kilograms | 614,071 | 619,201 | 580,201 | 523,809 | 497,853 |
| Iron and steel: | | | | | | |
| Ore and concentrate: | | | | | | |
| Gross weight | thousand tons | 28,226 | 29,385 | 30,489 | 31,946 | 30,830 |
| Fe content | do. | 18,347 | 19,100 e/ | 18,903 | 19,806 | 19,115 |
| Metal: | | | | | | |
| Pig iron | do. | 6,498 | 6,121 | 6,047 | 6,224 | 6,014 |
| Direct-reduced iron | do. | 854 | 833 | 980 | 950 | 960 |
| Ferroalloys, electric arc furnace: | | | | | | |
| Chromium ferroalloys | do. | 771 | 834 | 1,104 | 1,341 | 1,383 |
| Ferromanganese | do. | 270 | 393 | 591 | 480 | 547 e/ |
| Ferrosilicon | do. | 64 | 99 | 120 | 90 | 180 e/ |
| Ferrovanadium e/ | do. | 1 | 1 | 1 | 1 | 1 |
| Silicomanganese | do. | 267 | 268 | 290 | 280 e/ | 150 e/ |
| Silicon metal | do. | 35 | 38 | 36 | 30 | 35 e/ |
| Crude steel | do. | 9,061 | 8,726 | 8,320 | 8,511 | 7,968 |
| Lead: | | | | | | |
| Concentrate, Pb content | | 75,806 | 100,171 | 95,824 | 88,449 | 88,613 |
| Smelter, secondary | | 29,000 | 31,800 | 31,900 | 32,100 | 33,000 |
| Manganese: | | | | | | |
| Ore and concentrate, gross weight: | | | | | | |
| Metallurgical: | | | | | | |
| More than 48% manganese | thousand tons | 1,331 | 1,239 | 1,533 | 1,708 | 1,845 |
| 45% to 48% manganese | do. | 279 | 237 | 67 | 106 | 86 |
| 40% to 45% manganese | do. | 273 | 299 | 196 | 191 | 118 |
| 30% to 40% manganese | do. | 491 | 665 | 1,006 | 1,145 | 1,133 |
| Total metallurgical 4/ | do. | 2,375 | 2,440 | 2,801 | 3,151 | 3,182 |
| Chemical: | | | | | | |
| More than 65% manganese dioxide | do. | 16 | -- | -- | -- | -- |
| 35% to 65% manganese dioxide | do. | 73 | 67 | 50 | 48 | 58 |
| Total chemical | do. | 89 | 67 | 50 | 48 | 58 |
| Grand total | do. | 2,464 | 2,507 | 2,851 | 3,199 | 3,240 |
| Metal, electrolytic e/ | do. | 35 | 35 | 35 | 35 | 35 |
| Nickel: | | | | | | |
| Mine output, concentrate, nickel content e/ | | 28,400 3/ | 30,800 | 31,800 | 30,700 | 33,613 3/ |
| Metal, electrolytic | | 27,621 | 29,868 | 30,751 | 29,803 | 33,362 |

See footnotes at end of table.

## TABLE 1--Continued
## SOUTH AFRICA: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

| Commodity | | 1992 | 1993 | 1994 | 1995 | 1996 |
|---|---|---|---|---|---|---|
| METALS--Continued | | | | | | |
| Platinum-group metals | kilograms | 152,891 | 176,167 | 183,926 | 184,377 | 188,959 |
| Silver | do. | 182,723 | 192,418 | 197,767 | 174,279 | 166,536 |
| Thorium, monazite concentrate, gross weight e/ | | 400 | 400 | 131 3/ | -- | -- |
| Tin: | | | | | | |
| Cassiterite concentrate: | | | | | | |
| Gross weight e/ | | 1,500 | 1,200 | -- r/ | -- | -- |
| Sn content | | 592 r/ | 452 | -- r/ | -- | -- |
| Metal: | | | | | | |
| Primary 5/ | | 592 | 452 | 43 | -- | -- |
| Secondary e/ | | 60 | 50 | 50 | -- | -- |
| Titanium: e/ | | | | | | |
| Rutile concentrate | | 85,000 | 86,000 | 78,000 | 90,000 | 90,000 |
| Titaniferous slag 6/ | thousand tons | 929 | 937 | 819 | 990 | 1,000 e/ |
| Uranium oxide | | 2,222 | 2,008 | 2,069 | 1,702 | 1,706 |
| Vanadium, vanadium metal content | | 14,285 | 15,051 | 15,656 | 16,298 | 15,685 |
| Zinc: | | | | | | |
| Concentrate: | | | | | | |
| Gross weight e/ | | 133,892 3/ | 140,000 | 140,000 | 130,000 | 142,000 |
| Zn content | | 71,928 | 77,096 | 76,361 | 70,241 | 76,853 |
| Metal, smelter | | 83,208 | 96,154 | 93,850 | 98,782 | 101,100 |
| Zirconium concentrate (baddeleyite and zircon) e/ | | 243,000 | 243,000 | 240,000 | 260,000 | 260,000 |
| INDUSTRIAL MINERALS | | | | | | |
| Aluminosilicates: | | | | | | |
| Andalusite | | 230,333 | 187,708 | 206,291 | 206,378 | 228,010 |
| Sillimanite | | 632 | 569 | 525 | 317 | 303 |
| Asbestos | | | | | | |
| Amosite | | 5,132 | -- | -- | -- | -- |
| Chrysotile | | 103,660 | 92,380 | 85,857 | 81,246 | 51,776 |
| Crocidolite | | 24,476 | 11,614 | 6,273 | 7,396 | 5,344 |
| Total | | 133,268 | 103,994 | 92,130 | 88,642 | 57,120 |
| Barite | | 3,570 | 2,000 | 1,945 | 6,048 | 7,428 |
| Calcite | | 13,764 | 14,094 | 14,660 | 10,666 | 10,700 |
| Cement, hydraulic | thousand tons | 7,028 | 7,356 | 7,905 | 9,071 | 7,668 |
| Clays: | | | | | | |
| Attapulgite | | 8,235 | 7,032 | 10,230 | 8,049 | 14,318 |
| Bentonite | | 43,977 | 50,441 | 71,773 | 70,927 | 48,076 |
| Fire clay | | 86,195 | 91,839 | 110,131 | 74,751 | 101,452 |
| Flint clay, raw and calcined | | 123,721 | 89,352 | 131,590 | 118,688 | 113,645 |
| Kaolin | | 131,765 | 147,349 | 131,863 | 146,587 | 146,496 |
| Brick clay, local sales | thousand tons | 1,072 | 1,028 | 1,386 | 2,909 | 3,013 |
| Diamond, natural: | | | | | | |
| Gem e/ | thousand carats | 4,600 | 4,600 | 4,900 | 4,300 | 4,400 |
| Industrial e/ | do. | 5,556 | 5,724 | 5,954 | 5,383 | 5,546 |
| Total | do. | 10,156 | 10,324 | 10,854 | 9,683 | 9,946 |
| Diatomite | | 576 | -- | -- | -- | -- |
| Feldspar | | 49,425 | 56,761 | 37,156 | 47,874 | 54,193 |
| Fluorspar: | | | | | | |
| Acid-grade | | 230,790 r/ | 194,778 r/ | 166,761 | 177,000 | 205,344 |
| Ceramic-grade e/ | | 6,000 | 3,800 | -- | -- | -- |
| Metallurgical-grade e/ | | 23,000 | 19,000 | 7,497 | 18,794 | 12,000 |
| Total | | 259,790 r/ | 217,578 r/ | 174,258 | 195,794 | 217,344 |
| Gemstones, semiprecious: | | | | | | |
| Rose quartz | kilograms | 100,834 | 85,500 | -- | -- | -- |
| Tiger's eye | do. | 620,827 | 548,386 | 531,418 | 242,552 | 250,435 |
| Gypsum, crude | | 333,771 | 284,389 | 304,337 | 288,178 | 340,688 |
| Industrial or glass sand (quartz) | thousand tons | 1,750 | 1,738 | 1,920 | 2,180 | 2,167 |
| Lime 5/ | do. | 1,686 | 1,599 | 2,891 | 1,688 | 1,650 |
| Magnesite, crude | | 60,085 | 67,403 | 71,726 | 84,639 | 71,358 |
| Mica, scrap and ground | | 2,079 | 1,991 | 1,973 | 2,137 | 1,515 |

See footnotes at end of table.

### TABLE 1--Continued
### SOUTH AFRICA: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

| Commodity | | 1992 | 1993 | 1994 | 1995 | 1996 |
|---|---|---|---|---|---|---|
| INDUSTRIAL MINERALS--Continued | | | | | | |
| Nitrogen: N content of ammonia | | 540,500 | 683,400 | 754,000 | 758,500 | 769,800 |
| Perlite | | 97 | 328 | 914 | 1,338 | 1,300 |
| Phosphate rock: | | | | | | |
| Gross weight | thousand tons | 3,080 | 2,466 | 2,545 | 2,787 | 3,077 |
| Phosphorus pentoxide content e/ | do. | 1,201 | 962 | 995 | 1,087 | 1,200 |
| Pigments, mineral, natural: | | | | | | |
| Ochers | | 890 | 1,175 | 1,789 | 2,316 | 484 |
| Oxides | | 224 | 11 | 295 | 2,940 | 159 |
| Total | | 1,114 | 1,186 | 2,084 | 5,256 | 643 |
| Salt | | 701,991 | 613,301 | 414,463 | 311,388 | 253,403 |
| Sodium sulfate, natural | | 37,169 | 36,380 | 44,544 | 43,971 | 46,947 |
| Stone, n.e.s.: | | | | | | |
| Dimension: | | | | | | |
| Granite and norite 5/ | | 574,747 | 528,310 | 618,781 | 812,220 | 635,005 |
| Marble 7/ | | 17,245 | 20,615 | 12,450 | 5,837 | 689 |
| Slate 5/ | | 26,344 | 22,019 | 15,501 | 11,891 | 11,940 |
| Crushed and broken: | | | | | | |
| Limestone and dolomite | thousand tons | 19,782 | 18,215 | 19,548 | 19,738 | 22,038 |
| Nepheline syenite | | 174,864 | -- | 98,667 | 145,459 | 145,000 |
| Quartzite 5/ | thousand tons | 8,162 | 8,224 | 9,258 | 9,123 | 8,515 |
| Shale: | | | | | | |
| For cement | do. | 301 | 331 | 371 | 325 | 383 |
| Other 5/ | do. | 3,254 | 2,767 | 2,157 | 3,248 | 3,000 e/ |
| Total | do. | 3,555 | 3,098 | 2,528 | 3,573 | 3,383 |
| Aggregate and sand, n.e.s. | do. | 19,477 | 15,824 | 18,294 | 20,594 | 20,792 |
| Sulfur: | | | | | | |
| S content of pyrite | do. | 296 | 323 | 252 | 159 | 184 |
| Byproduct: | | | | | | |
| Metallurgy e/ | do. | 56 | 82 | 118 | 117 | 91 |
| Petroleum | do. | 166 | 171 | 209 | 233 | 200 |
| Total 4/ | do. | 518 | 575 | 579 | 509 | 475 |
| Talc and related materials: | | | | | | |
| Talc | | 13,882 | 8,798 | 8,202 | 9,173 | 16,397 |
| Pyrophyllite (wonderstone) | | 3,053 | 4,287 | 5,507 | 5,519 | 2,140 |
| Vermiculite | | 170,399 | 211,143 | 223,478 | 221,748 | 186,082 |
| MINERAL FUELS AND RELATED MATERIALS | | | | | | |
| Coal (salable product): | | | | | | |
| Anthracite | thousand tons | 3,345 | 3,246 | 2,225 | 2,137 | 2,513 |
| Bituminous | do. | 171,047 | 178,980 | 193,625 | 204,073 | 204,468 |
| Total | do. | 174,392 | 182,226 | 195,850 | 206,210 | 206,981 |
| Petroleum refinery products: | | | | | | |
| Liquefied petroleum gases | thousand 42-gallon barrels | 1,543 | 2,460 | 1,825 | 3,285 r/ | 3,300 e/ |
| Gasoline | do. | 54,545 | 57,446 | 59,860 | 73,730 r/ | 74,000 e/ |
| Jet fuel | do. | 6,480 | 6,346 | 7,665 | 8,760 r/ | 9,000 e/ |
| Kerosene | do. | 3,906 | 4,678 | 5,475 | 7,300 4/ | 7,300 e/ |
| Distillate fuel oil | do. | 33,943 | 31,136 | 35,770 | 50,005 r/ | 50,000 e/ |
| Residual fuel oil | do. | 15,884 | 16,000 e/ | 20,075 | 22,995 4/ | 23,000 e/ |
| Lubricants (including greases) | do. | 2,240 | 2,503 | 1,280 | 3,000 r/ e/ | 3,000 e/ |
| Bitumen | do. | 1,739 | 1,784 | 895 | 2,000 r/ e/ | 2,000 e/ |
| Other e/ 8/ | do. | 686 3/ | 700 | 380 3/ | 4,855 r/ | 4,900 e/ |
| Total 9/ | do. | 120,966 | 123,053 | 133,225 | 175,930 r/ | 176,500 e/ |

e/ Estimated. r/ Revised.

1/ Table includes data available through Jan. 31, 1998.

2/ Data are for the year ending June 30 of that stated.

3/ Reported figure.

4/ Data may not add to totals shown because of independent rounding.

5/ Domestic sales plus exports.

6/ Except for about 45,000 t/yr slag derived from titaniferous magnetite by Highveld Steel, titaniferous slag is all from the smelting of ilmenite and likely represents most of that mineral's production, for which data are unavailable.

7/ Converted from reported cubic meters using 1 cubic meter = 2.7 tons.

8/ Includes naphthas, paraffin wax, petroleum coke, petrochemical feedstocks, unfinished oils, white spirits, and blending compounds.

9/ Excludes refinery fuel and losses.

## TABLE 2
## SOUTH AFRICA: STRUCTURE OF THE MINERAL INDUSTRY IN 1996

(Thousand metric tons unless otherwise specified)

| Major commodities | Major operating companies and major equity owners 1/ | Location of main facilities | Annual capacity |
|---|---|---|---|
| Aluminum | Aluminium South Africa (Pty.) Ltd. (Gencor, 48%; IDC, 34%; other, 18%) | Bayside smelter at Richards Bay<br>Hillside smelter at Richards Bay | 210 hot metal.<br>466 hot metal. |
| Andalusite | Rhino Andalusite Mines (Pty.) Ltd. (Anglovaal Ltd., 77%) | Timeball Mine, near Thabazimbi | 120. |
| Do. | Damrec of France (private, 100%) | Annesley Mine at Penge, 50 kilometers north of Steelpoort | 75. |
| Do. | do. | Andafrax Mine at Groot Marico, 60 kilometers west of Rustenburg | 12. |
| Do. | Cullinan Minerals Ltd. (South African Mutual Life Insurance, 44%; Fermain Nom Ltd., 8%; AAC) | Krugerspost Mine, near Lydenburg | 50. |
| Do. | Verref Mining (Pty.) Ltd. (AAC) | Havercroft Mine at Penge, 50 kilometers north of Steelpoort | 36. |
| Do. | Hoogenoeg Andalusite (Pty.) Ltd. | Hoogenoeg Mine, 60 kilometers northeast of Potgietersrus | 15. |
| Antimony | Consolidated Murchison Ltd. (JCI, 24.1%; Middle Witwatersrand, 5.5%; Anglovaal Ltd., 2.4%) | 50 kilometers west of Phalaborwa | 9.5 Sb concentrate. |
| Asbestos | Gencor Ltd. (Gencor Beherend Bpk, 54.8%; AAC, 0.9%) | Penge Mine, 50 kilometers north of Steelpoort | 48 (amosite). |
| Do. | do. | Klipfontein Mine, near Sishen | NA (crocidolite). |
| Do. | Anglo Dutch Exploration & Mining Co. (Pty.) Ltd. | Stella Mine, 25 kilometers east of Barberton | NA (chrysotile). |
| Cement | Alpha Ltd. (AAC) | Dudfield plant near Lichtenburg | 1,830. |
| Do. | do. | Ulco plant 60 kilometers northwest of Kimberley | 1,241 |
| Do. | Blue Circle Cement (Pty.) Ltd. (BCC) | Plant at Lichtenburg | 2,000. |
| Do. | Natal Portland Cement Co. (Pty.) Ltd. (AAL, 33.3%; BCC, 33.3%; Pretoria Portland Cement, 33.3%) | Simumu plant, 125 kilometers southwest of Durban | 580. |
| Do. | Pretoria Portland Cement Co. Ltd. (Barlow Rand Group, 60.3%) | De Hoek, Herculese, Jupiter, Slurry, Riebeeck West, and Port Elizabeth | 4.59 Mt (combined), clinker. |
| Chromite | Samancor Ltd. (Gencor, 41%; Delauney Ltd., 24.9%; De Beers, 8.7%) | Winterveld and Tweefontein Mines at Steelpoort | 960 ore. |
| Do. | do. | Montrose Mine, near Lydenburg | 360 ore. |
| Do. | do. | Mooinooi Mine, 30 kilometers west of Brits | 580 ore. |
| Do. | do. | Millsell Mine, 8 kilometers east of Rustenburg | 300 ore. |
| Do. | do. | Elandsdrift Mine, near Brits | 420 ore. |
| Do. | Consolidated Metallurgical Industries (Pty.) Ltd. (JCI, 49.9%; AAC, 26.4%) | Purity Mine, near Rustenburg | 360 ore; 252 concentrate. |
| Do. | Lavino South Africa (Pty.) Ltd. (Anglovaal Ltd., 51%; Middle Witwatersrand, 49%) | Grootboom Mine, near Lydenburg | 500 ore. |
| Do. | Dilokong Chrome Mine (Pty.) Ltd. (Mining Corp. Ltd., 100%) | Dilokong Mine, near Lydenburg | 480 ore. |
| Do. | Chromecorp Technology (Pty.) Ltd. (CI Chromeinvest AG, Germany, 50%; Investinox AG, Germany, 50%) | Chroombronne Mine, near Rustenburg | 576 ore; 432 concentrate. |

See footnotes at end of table.

TABLE 2--Continued
SOUTH AFRICA: STRUCTURE OF THE MINERAL INDUSTRY IN 1996

(Thousand metric tons unless otherwise specified)

| Major commodities | Major operating companies and major equity owners 1/ | Location of main facilities | Annual capacity |
|---|---|---|---|
| Coal | Anglo American Coal Corp. Ltd. (AAC, 51.4%; ASA Ltd., 2.2%) | 13 collieries in the eastern Transvaal and Natal | 46,000 anthracite and bituminous. |
| Do. | Ingwe Coal Corp. (Trans-Natal Corp. Ltd.; 49.1%; Rand Mines Ltd., 45.9%; other, 5%) | 12 collieries in the eastern Transvaal and Natal | 59,000 anthracite and bituminous. |
| Do. | Duvha Opencast Services (Pty.) Ltd. (Rand Mines Ltd., 71%) | Duvha Colliery, 18 kilometers southeast of Witbank | 11,000 bituminous. |
| Do. | Sasol Mining (Pty.) Ltd. | Sigma Mine, 75 kilometers south of Johannesburg | 7,000 bituminous. |
| Do. | do. | Secunda Collieries, 75 kilometers south of Witbank | 31,000 bituminous. |
| Do. | Iscor Ltd. (De Beers, 3.4%; AAC, 0.7%) | Grootegeluk Mine, 120 kilometers north of Thabazimbi | 6,300 bituminous;<br>1,700 coking coal. |
| Do. | do. | Durnacol Mine at Dannhauser, 40 kilometers south of Newcastle | 1,200 coking coal. |
| Do. | do. | Hlobane Mine, 100 kilometers east of Newcastle | 700 coking coal. |
| Do. | do. | Tshikondeni Mine in Venda, about 100 kilometers southeast of Messina | 200 coking coal. |
| Copper | Palabora Mining Co. Ltd. (Rio Tinto Zinc Corp. plc, 38.9%; AAC, 19.1%; De Beers, 9.5%) | Palabora Mine and plant at Phalaborwa | 130 metal. |
| Do. | O'Okiep Copper Co. Ltd. (GFSA, 82%; Mellon Securities Trust Co., 18%) | O'Okiep copper mine, 20 kilometers north of Okiep | 40. |
| Do. | Black Mountain Mineral Development Co. (Pty.) Ltd. (GFSA, 55.4%; Phelps Dodge Corp., 44.6%) | Black Mountain Mine, 100 kilometers northwest of Okiep | 2.5 Cu in concentrate. |
| Diamond, million carats | De Beers (Anglo American Investment Trust Ltd., 25.8%; AAC, 6.9%) | Finsch Mine, 100 kilometers west of Kimberley | 3.5. e/ |
| Do. do. | do. | Kimberley Mines, Kimberley | 0.8. e/ |
| Do. do. | do. | Koffiefontein Mine, 70 kilometers south of Kimberley | 0.25. e/ |
| Do. do. | do. | Namaqualand Mines, 50 kilometers north of Port Nolloth | 1.0. e/ |
| Do. do. | do. | Premier Mine, 70 kilometers east of Pretoria | 1.7. e/ |
| Do. do. | do. | Venetia Mine, 150 kilometers north of Potgietersrus | 5. e/ |
| Fluorspar | Vergenoeg Mining Corp. (Pty.) Ltd. (Bayer AG, Germany, 100%) | Vergenoeg Mine, 90 kilometers east of Pretoria | 200 acid- and metallurgical-grade fluorspar. e/ |
| Do. | Phelps Dodge Mining (Pty.) Ltd. (Phelps Dodge Corp., U.S., 100%) | Witkop Mine, 130 kilometers west of Johannesburg | 75 acid-grade fluorspar. e/ |
| Do. | Van Den Heever Vloeispaat Werke | Van Den Heever Mine, 120 kilometers west of Johannesburg | 50. e/ |

See footnotes at end of table.

## TABLE 2--Continued
## SOUTH AFRICA: STRUCTURE OF THE MINERAL INDUSTRY IN 1996

(Thousand metric tons unless otherwise specified)

| Major commodities | Major operating companies and major equity owners 1/ | Location of main facilities | Annual capacity |
|---|---|---|---|
| Gold: tons | AAC (De Beers, 38.7%; ASA Ltd., 0.1%) | Freegold near Welkom, Vaal Reefs near Klerksdorp, Western Deep Levels, 70 kilometers southwest of Johannesburg | 260 Au. |
| Do. do. | GFSA (GFSA Holdings Ltd., 43%; Anglo American Gold Investment Co., 10.8%; AAC, 8.9%; De Beers, 1.3%) | East Driefontein and West Driefontein, 65 kilometers southwest of Johannesburg; Kloof, 55 kilometers southwest of Johannesburg; and others | 125 Au. |
| Do. do. | Gencor (Gencor Beherend Bpk, 54.8%; AAC, 0.9%) | Buffelsfontein near Klerksdorp; Beatrix, 35 kilometers southeast of Welkom; Winkelhaak, 120 kilometers southeast of Johannesburg; others | 90 Au. |
| Do. do. | Rand Mines Ltd. | Harmony Mine, 20 kilometers southeast of Welkom and others | 55 Au. |
| Do. do. | Anglovaal Ltd. (Anglovaal Holdings Ltd., 49.7%;, South African Mutual Life Insurance, 10.7%) | Hartebeestfontein Mine near Klerksdorp and others | 45 Au. |
| Do. do. | JCI (AAC, 39.8%; South African Mutual Life Insurance, 8.9%; De Beers, 8.4%) | Randfontein Mine, 20 kilometers west of Johannesburg; Western Areas Mine, 30 kilometers southwest of Johannesburg; and others | 41 Au. |
| Iron and steel: | | | |
| Iron ore | Iscor Ltd. (De Beers, 3.4%; AAC, 0.7%) | Sishen Mine at Sishen | 21,500 ore. |
| Do. | do. | Thabazimbi Mine at Thabazimbi | 2,500 ore. |
| Do. | Highveld Steel and Vanadium Corp. Ltd. (Anglo American Industrial Corp. Ltd., 51.8%) | Mapochs Mine at Roossenekal, 60 kilometers west of Lydenburg | 3,000 titaniferous and vanadiferous magnetite ore. |
| Ferroalloys 2/ | Ferrometals Ltd. (Samancor Ltd., 100%) | Witbank | 320 ferrochromium. |
| Do. | Tubatse Ferrochrome (Pty.) Ltd. (Samancor Ltd., 100%) | Steelpoort | 300 ferrochromium. |
| Do. | Batlhako Ferrochrome (Pty.) Ltd. (Samancor Ltd., 100%) | Ruighoek Mine site, 80 kilometers southwest of Thabazimbi | 20 ferrochromium. |
| Do. | Samancor Ltd. (100%) | Middelburg | 234 ferrochromium. |
| Do. | do. | Krugersdorp, 30 kilometers west of Johannesburg | 120 ferrochromium. |
| Do. | Consolidated Metallurgical Industries (Pty.) Ltd. (JCI, 49.9%; AAC, 26.4%) | Lydenburg | 210 ferrochromium. |
| Do. | do. | Purity, at Rustenburg | 120 ferrochromium. |
| Do. | Chromecorp Technology (Pty.) Ltd. (CI Chromeinvest AG, Germany, 50%; Investinox AG, Germany, 50%) | Rustenburg | 200 ferrochromium. |
| Do. | Feralloys Ltd. (Associated Manganese Mines of South Africa Ltd., 100%) | Machadadorp, 80 kilometers east of Middelburg | 110 ferrochromium. |
| Do. | do. | Cato Ridge, 75 kilometers west of Durban | 130 high-carbon ferromanganese. |
| Do. | Metalloys Ltd. (Samancor Ltd., 100%) | Meyerton plant, 50 kilometers south of Johannesburg | 532 high-carbon ferromanganese;<br>200 silicomanganese. |
| Do. | Manganese Metal Co. (Pty) Ltd. (Samancor Ltd., 45.9%) | Plants at Krugersdorp and Nelspruit | 38 electrolytic manganese (total). |

See footnotes at end of table.

## TABLE 2--Continued
## SOUTH AFRICA: STRUCTURE OF THE MINERAL INDUSTRY IN 1996

(Thousand metric tons unless otherwise specified)

| Major commodities | Major operating companies and major equity owners 1/ | Location of main facilities | Annual capacity |
|---|---|---|---|
| Iron and steel--Continued: | | | |
| Ferroalloys--Continued: | Transvaal Alloys Pty. Ltd., (Highveld Steel and Vanadium Corp., 100%) | Witbank | 20 low-carbon ferromanganese;<br>175 silicomanganese. |
| Steel | Iscor Ltd. (De Beers, 3.4%; AAC, 0.7%) | Plant at Vanderbijlpark | 4,300. |
| Do. | do. | Newcastle plant | 2,000. |
| Do. | do. | Pretoria plant | 800. |
| Do. | do. | Cisco plant near Cape Town | 150. |
| Do. | do. | Corex plant in Pretoria | 300. |
| Do. | do. | Ex-Usko plant in Vereeniging | 450. e/ |
| Do. | Highveld Steel and Vanadium Corp. Ltd. (Anglo American Industrial Corp. Ltd., 51.8%; De Beers, 3.8%) | Witbank | 1,000. |
| Do. | Columbus Stainless, Ltd. (AAC and De Beers, 33.3%; Gencor, 33.3%; IDC, 33.3%) | Stainless steel plant at Middelburg | 660 |
| Manganese | Associated Manganese Mines of South Africa Ltd. (Associated Ore and Metal Corp. Ltd., 45%; Anglovaal Ltd., 44%) | Blackrock, Gloria, N'Chwaning Mines near Hotazel, 70 kilometers north of Sishen | 1,500 ore. |
| Do. | Samancor Ltd. (100%) | Mamatwan and Wessels Mines near Hotazel | 3,000 ore. |
| Petroleum products million 42-gallon barrels | Shell and British Petroleum South Africa Petroleum Refineries Pty. Ltd. (Shell South Africa, 50%; British Petroleum Co., 50%) | Sanref refinery in Durban | 73 crude. |
| Do. | Caltex Oil SA Pty. Ltd. (private, 100%) | Refinery in Cape Town | 33 crude. |
| Do. | National Petroleum Refiners of South Africa Pty. Ltd. (SASOL, 100%) | Refinery in Secunda, 100 kilometers southeast of Johannesburg | 28 crude. |
| Do. | Genref (Engen Ltd., 62%) | Refinery in Durban | 24 crude. |
| Phosphate | Phosphate Development Corp. Ltd. (Foskor Ltd.) (IDC, 100%) | Foskor mine and plant at Phalaborwa | 3,800. e/ 3/ |
| Platinum-group metals tons | Rustenburg Platinum Mines Ltd. (JCI, 32.6%; AAC, 23.9%; Lydenburg Platinum Ltd., 8.3%; ASA Ltd., 0.8%) | Rustenburg Mine near Rustenburg, Union and Amandelbult Mines about 50 kilometers south of Thabazimbi | 70 PGM. e/ |
| Do. do. | Lebowa Platinum Mines Ltd. (Rustenburg Platinum Holdings, 21.5%; JCI, 20.1%; Lydenburg Platinum Ltd., 20.1%; AAC, 14.4%) | Atok Mine, 70 kilometers east of Potgietersrus | 10 PGM. e/ |
| Do. do. | Potgietersrust Platinums Ltd. (JCI, 30.23%; AAC, 22.65%) | Open pit mine near Potgietersrus | 10 PGM (in concentrates.) |
| Do. do. | Impala Platinum Ltd. (Gencor, 40.7%; Genbel Investments Corp. Ltd., 10.8%) | Bafokeng North, Bafokeng South, Wildebeestfontein North, and Wildebeestfontein South Mines, 20 kilometers north of Rustenburg | 35 PGM. e/ |
| Do. do. | Eastern Platinum Ltd. (Lonrho Plc., 73%; Impala Platinum Holdings Ltd., 27%) | 40 kilometers northeast of Rustenburg | 3 PGM. e/ |
| Do. do. | Western Platinum Ltd. (Lonrho Plc., 73%; Impala Platinum Holdings Ltd., 27%) | 20 kilometers east of Rustenburg | 10 PGM. e/ |
| Do. do. | do. | Karee Mine, 25 kilometers northeast of Rustenburg | 5 PGM. e/ |

See footnotes at end of table.

TABLE 2--Continued
SOUTH AFRICA: STRUCTURE OF THE MINERAL INDUSTRY IN 1996

(Thousand metric tons unless otherwise specified)

| Major commodities | | Major operating companies and major equity owners 1/ | Location of main facilities | Annual capacity |
|---|---|---|---|---|
| Platinum-group metals--Continued: | tons | Barplats Investments Ltd. (Impala Platinum Holdings Ltd., 38%; Rand Mines Ltd., 30.6%; Vansa Vanadium, 3.2%) | Crocodile River Mine near Brits | 10 PGM. |
| Do. | do. | Northam Platinum Ltd. (GFSA, 63%; New Wits Ltd., 3.1%) | Northeast of Northam, 20 kilometers south of Thabazimbi | 10 PGM. e/ |
| Pyrophyllite | | Wonderstone 1937 Ltd. (Associated Ore and Metal Co. Ltd., 100%) | Gestoptefontein Quarry near Ottosdal, 70 kilometers west of Klerksdorp | 2. e/ |
| Titanium: | | | | |
| Mineral concentrates | | Tisand (Pty.) Ltd./Richards Bay Minerals (Rio Tinto Zinc Corp. Plc., 50%; Gencor, 50%) | Opencast operations near Richards Bay | 125 rutile concentrate e/; 1,280 ilmenite concentrate. e/ |
| Do. | | Namakwa Sands project (AAC, 80%; De Beers, 20%) | Opencast mine near Koekenaap, 300 kilometers north of Cape Town | 16 rutile concentrate; 220 ilmenite concentrate. 4/ |
| Titanium slag | | Richards Bay Iron and Titanium Corp./ Richards Bay Minerals (Rio Tinto Zinc Corp. plc, 50%; Gencor, 50%) | Smelter at Richards Bay | 1,000 slag. |
| Do. | | Namakwa Sands project (AAC, 80%; De Beers, 20%) | Smelter near Koekenaap, 300 kilometers north of Cape Town | 195 slag; 4/<br>120 pig iron |
| Do. | | Highveld Steel and Vanadium Corp. Ltd. | Steel plant at Witbank | 48 slag. e/ |
| Uranium | tons | Vaal Reefs Exploration and Mining Co. Ltd. (Anglo American Gold Investment Co., 16.8%; AAC, 10.8%; ASA Ltd., 3.1%) | Mine and plant near Klerksdorp | 2,000 uranium oxide. e/ |
| Do. | do. | Hartebeestfontein Gold Mining Co. Ltd. (Zandpan Gold Mining Co. Ltd., 19.6%; Anglo American Gold Investment Co., 15.5%; AAC, 7.5%; Anglovaal Ltd., 4.6%) | Mine and plant, 5 kilometers southeast of Klerksdorp | 400 uranium oxide. e/ |
| Do. | do. | Western Areas Gold Mining Co. Ltd. (Elsburg Gold Mining Co. Ltd., 48.7%; JCI, 6.5%) | Western Areas Mine, 30 kilometers southwest of Johannesburg | 500 uranium oxide. e/ |
| Do. | do. | Palabora Mining Co. Ltd. | Palabora Mine and plant at Phalaborwa | 200 uranium oxide. e/ |
| Vanadium | do | Highveld Steel and Vanadium Corp. Ltd. | Mapochs Mine near Lydenburg | 25,000 vanadium pentoxide. e/ |
| Do. | do. | do. | Highveld steel plant in Witbank | 17,000 vanadium pentoxide. |
| Do. | do. | do. | Highveld Vantra plant in Witbank | 8,000 vanadium pentoxide. |
| Do. | do. | Vametco Minerals Corp. (Strategic Metals Corp., USA, 100%) | Krokodilkraal Mine and plant near Brits | 5,000 vanadium pentoxide. e/ |
| Do. | do. | Transvaal Alloys Pty. Ltd., (Highveld Steel and Vanadium Corp. Ltd., 100%) | Wapadskloof Mine and plant, 60 kilometers northeast of Middelburg | 2,250 vanadium pentoxide. e/ |
| Do. | do. | Vanadium Technology Ltd. (Chromecorp Technology (Pty.) Ltd., 100%) | Kennedy's Vale (ex-Vansa Vanadium) Mine and plant, near Lydenburg | 3,600 vanadium pentoxide. |
| Do. | do. | Rhombus Vanadium Holdings Ltd. (Rhombus Exploration Ltd., 50%; Usko Ltd., 50%) | Ba-Mogopa Mine and Usko plant near Brits | 13,500 vanadium pentoxide. e/ |
| Vermiculite | | Palabora Mining Co. Ltd. | Palabora Mine and plant at Phalaborwa | 230. e/ |
| Zinc | | Zinc Corp. of South Africa Ltd. (GFSA, 56%; Iscor Ltd., 35%) | Struisbult Springs Works in Springs, southeast of Johannesburg | 90 Zn. |
| Do. | | Black Mountain Mineral Development Co. (Pty.) Ltd. | Black Mountain Mine near Aggeneys, 100 kilometers northeast of Okiep | 26 Zn (in concentrate). |

See footnotes at end of table.

## TABLE 2--Continued
## SOUTH AFRICA: STRUCTURE OF THE MINERAL INDUSTRY IN 1996

(Thousand metric tons unless otherwise specified)

| Major commodities | Major operating companies and major equity owners 1/ | Location of main facilities | Annual capacity |
|---|---|---|---|
| Zirconium | Tisand (Pty.) Ltd./Richards Bay Minerals | Opencast mines near Richards Bay | 300 zircon concentrate. |
| Do. | Namakwa Sands project (AAC, 80%; De Beers, 20%) | Opencast mine along coast about 300 kilometers north of Cape Town | 140 zircon concentrate. |
| Do. | Palabora Mining Co. Ltd. | Palabora Mine and plant at Phalaborwa | 13.2 baddeleyite. e/ |
| Do. | Phosphate Development Corp. Ltd. | Plant at Phalaborwa | 12.5 baddeleyite. e/ |

e/ Estimated.

1/ Abbreviations of company names used are as follows: Anglo American Corp. of South Africa Ltd. (AAC); De Beers Consolidated Mines Ltd. (De Beers); General Mining, Metals and Minerals Ltd. (Gencor); Gold Fields of South Africa Ltd. (GFSA); Investment Development Corp. of South Africa (IDC); and Johannesburg Consolidated Investment Co. Ltd. (JCI).

2/ Depending on markets furnace capacity can switch between FeCr and FeMn.

3/ Most of Foskor's phosphate output is from phosphate concentrates supplied by the neighboring Palabora copper mine.

4/ Full capacity shown will be reached in 2000.

## TABLE 3
## SOUTH AFRICA: RESERVE BASE OF MAJOR MINERALS 1/ FOR 1996

(Million metric tons unless otherwise specified)

| Commodity | | Reserve base |
|---|---|---:|
| Andalusite 2/ | | 51 |
| Antimony | thousand tons | 250 |
| Asbestos, fiber | | 8.2 |
| Chromium, ore | | 3,200 |
| Coal, recoverable | | 55,300 |
| Cobalt | thousand tons | 15 |
| Copper | | 13 |
| Fluorspar | | 36 |
| Gold | thousand tons | 40 |
| Iron ore | | 5,900 |
| Lead | | 3 |
| Manganese | | 4,000 |
| Nickel | | 11.8 |
| Phosphate rock, concentrates | | 2,310 |
| Platinum-group metals | thousand tons | 62.8 |
| Silver | do. | 10 |
| Titanium | | 72 |
| Uranium 3/ | thousand tons | 179.1 |
| Vanadium | | 12.5 |
| Vermiculite | | 80 |
| Zinc | | 15 |
| Zirconium | | 14.3 |

1/ Metallic minerals are contained metal.

2/ Includes the alumino-silicate, sillimanite.

3/ Recoverable at a cost of less than $80 per kilogram.

Source: Chamber of Mines Statistical Tables 1996, p. 4. (Minerals Bureau December 31, 1996 estimates.)

## THE MINERAL INDUSTRY OF

# SWAZILAND

### By George J. Coakley

In 1996, mining activities in Swaziland remained at the same level as that of 1995, except overall production was lower compared with 1995 output. Exploration activities continued during the year although no significant findings were announced. For example, Southern Era Resources Ltd. of Canada began exploration on two licences covering historic gold mines. They anounced in their 1996 Annual Report that all surface workings at the Daisy property have been mapped and a reference grid was established in the preparation for a core drilling program in 1997. At Southern Era's Piggs Peak gold property, a $350,000 exploration program of underground rehabilitation, sampling, and drilling was initiated to test its bulk minable potential.[1]

Asbestos, coal, diamond, and crushed stone remained the main mining products, and overall mining revenue in 1996 contributed slightly over 2% of the gross domestic product. The decrease in mining revenue was primarily attributed to low grades of diamond ore and the general depletion of reserves of coal, asbestos, and diamonds. For example, the operators of the Bulembu asbestos mine were granted a prospecting permit to explore the western extremity of this operating mine for possible extension of mine life; the exploration did not show any promising results. Asbestos production was estimated at 20,000 tons in 1996, about 30% lower than 1995 output.

The Maloma Colliery remained the only coal-producing mine during 1996. Although the company was successful in transferring some of the production line to an underground operation, overall performance was disappointing, since production was 16% lower in 1996 than 1995 output. High-grade anthracite was trucked 25 kilometers to the nearest railroad terminal and railed either to Richards Bay or Durban port facilities for export and Japan and other Asian markets. During the year, the port of Maputo in Mozambique was not available to receive Swazi coal for export.

For the second year in a row, diamond production was lower with a total output of 10,000 carats in 1996. At the Dokolwayo diamond mine, the production was primarily from unoxidized kimberlite, which yielded low-grade stones, and was an expensive operation. As a result of these factors, the owners, including Trans Hex International Ltd. of South Africa, notified the government that the mine would be closed by yearend.

The production of crushed stone for road building and construction stone decreased by 12,000 cubic meters during the year. The production from both Kwalini and Tonkwane quarries was far below the peak year of 1994. The market sluggishness was attributed to lack of governmental programs on building new highways and upgrading the present system of transportation. It was anticipated that once Malagwane Hill road project commences, the demand for aggregate will increase. By the end of the year, the Kwalini quarry was under new management, and new production equipment was ordered.

Swaziland's road and railroad network was considered to be generally adequate to serve the mining industry, with the exception of the asbestos mine. The asbestos mine, located in mountainous terrain, ships its ore by aerial bucket way to the nearby town of Barberton, South Africa. Swaziland's first railroad, from Kadake to the Mozambique border, was built to export ore from the now closed iron mine northwest of Mbabane. The same line served to export coal when security conditions in Mozambique permitted. The portion of the railroad from Kadake to Matsapha has been inactive for many years and its rails were recently taken up.

A newer, north-south railroad was built to allow the rapid transportation of South African goods, including coal, through Swaziland, chiefly to the South African ports of Richards Bay and Durban.

Swaziland's electrical generation capacity and grid have been a problem for industrial development. The generation capacity totaled about 60 megawatts, installed in a number of coal and diesel and/or fuel oil thermal plants. The coal-fired plants are designed for South African bituminous coal rather than the harder-to-ignite Swaziland anthracite. However, projects have been discussed to build anthracite-burning powerplants on the Swaziland coalfields, most notably at Mpaka where the proposal would involve reopening an old coal mine. Swaziland typically imports annually about $10 million to $13 million in electricity.

Except for coal, the future of mining in Swaziland is uncertain beyond the turn of the century. The Trans Hex 1996 Annual Report indicated that diamond resources at Dokolwayo were no longer economic. At the Bulembu asbestos mine, HVL Asbestos (Swaziland) Ltd. has expressed cautious optimism for finding modest additional reserves as a result of exploration between the existing ore body and the nearby South African border (Swaziland Department of Geological Survey & Mines, 1996). The results of current gold exploration are unlikely to be known until late 1997 or 1998.

### Reference Cited

Swaziland Department of Geological Survey & Mines, 1996.
Swaziland— Mining annual review-1996, Mining Journal (London), 1996, p. 143.

### Major Sources of Information

Ministry of Natural Resources and Energy

---

[1] Where necessary, values have been converted from Swazi emalangeni (E) to U.S. dollars at the rate of E3.8=US$1.00 in 1996.

P.O. Box 57
Mbabane, Swaziland
Telephone: (268) 46-244
Fax: (268)-42-436
Geological Survey and Mines Department

P.O. Box 9
Mbabane, Swaziland
Telephone: (268)-42-411
Fax: (268)-45-215

### TABLE 1
### SWAZILAND: PRODUCTION OF MINERAL COMMODITIES 1/ 2/

| Commodity 3/ | | 1992 | 1993 | 1994 | 1995 | 1996 e/ |
|---|---|---|---|---|---|---|
| Asbestos, chrysotile fiber | metric tons | 32,300 | 33,900 | 26,720 | 28,570 | 20,000 |
| Coal, anthracite | thousand metric tons | 100 | 50 | 228 | 172 | 144 |
| Diamond | carats | 50,500 | 61,700 | 76,100 | 75,000 | 70,000 |
| Stone, quarry products | thousand metric tons | 148 | 163 | 185 | 114 | 150 |

e/ Estimated.

1/ Estimated data are rounded to three significant figures.

2/ Includes data available through June 30, 1997.

3/ In addition to the commodities listed, modest quantities of crude construction materials (brick clay, sand and gravel) and pyrophyllite are produced, but output is not reported quantitatively, and information is inadequate to make reliable estimates of output levels.

### THE MINERAL INDUSTRY OF

# TANZANIA

### By George J. Coakley

Currently, agriculture is the most important sector of Tanzania's economy, employing more than 80% of the country's workforce and accounting for more than 50% of the gross domestic product and 85% of exports. However, encouraged by more aggressive Government investment policies, and the exploration successes reported in 1996, mining is on the verge of becoming a significant part of the Tanzanian economy. Although the country's natural resources include coal, cobalt, diamond, gemstones, graphite, iron ore, natural gas, nickel, and phosphate rock, gold will be the dominant mineral commodity in the future. The four most advanced gold projects reported a combined resource of 327,000 kilograms (kg) of gold by yearend 1996, with substantial potential for additions to this amount. At a gold price of $300 per troy ounce ($9,645 per kilogram), this resource has a gross in-place value of over $3 billion.

Administration of the mining sector is the responsibility of the Ministry of Water, Energy and Minerals under the Mining Act of 1979. Investment in the petroleum sectors was governed by the provisions of the 1980 Petroleum (Exploration and Production) Act. The Mining Law of 1979 has been modified by the Policy Issue Papers of 1983, which proposed the mineral wealth of Tanzania as the nation's heritage and gave the state majority ownership in mining activities. However, the Model Agreement of 1988 removed the Government majority ownership requirement. The incorporation of 1988 minerals trade policies into the 1979 Act and the establishment of the National Investment Promotion Center (IPC) helped to create a favorable environment for foreign investment. Prospectors must obtain exploration and development licenses through the IPC. Reconnaissance Licenses were issued for a period of 1 year and could be renewed once. These cover specific areas and minerals. Prospecting Licenses are issued for 3 years and are renewable up to 4 years depending on work performance. Mining licenses, when issued, give exclusive rights to investors to prospect, produce, and sell the minerals recovered. The mining licenses expire after 25 years or at the end of the estimated life of the deposit, whichever was shorter, and were renewable for another 15 years. The Government was currently reviewing the Mining Act and was to propose new legislation by 1998.

Since the early 1990's, the Government of Tanzania has attempted to improve the country's attractiveness to the international investment community with the 1990 National Investment Promotion Act and the creation of the IPC. The country has been successful in attracting mineral exploration and investment and has triggered a "gold rush" in the greenstone belts at the southern end of Lake Victoria. Exploration companies from Australia, Canada, South Africa, Sweden, and the United Kingdom have been very active in Tanzania since 1993 and 1994.

The 1979 Mining Act required that prospectors provide environmental statements with applications for permits before a license was issued. The National Environment Management Act of 1983 covered environmental matters and authorized a National Environmental Council to regulate environmental activities. Mining is not permitted in National Parks or in the Ngorongoro Conservation area but is allowed by special permits in game reserves.

Historically, diamonds and gold have been the most important minerals produced in Tanzania. Tanzania also produces construction materials, including cement and other industrial minerals. Fuel mineral production in Tanzania has been limited to coal and a small amount of petroleum refinery products. In 1996, production of gold, salt, and tin declined. However, large increases were observed in the production of coal, diamonds, precious and semiprecious gemstones, and graphite. *(See table 1.)*

Some of the impediments to Tanzania's developing its mineral industry include its poor infrastructure and lack of energy.

During the year, gold exploration and development planning dominated the industry news, with several companies announcing the discovery of significant gold resources.

For $25 million, Resolute Samantha Ltd. of Australia, now called Resolute Ltd., acquired a 50% interest in the Golden Pride gold prospect held by Samax Resources Ltd. of the United Kingdom. It will be the first of the new gold deposits to be developed. The Golden Pride resource was reported as proven and probable reserves of 13.5 million metric tons (Mt) grading 3.2 grams per ton (g/t) and a total reserve plus resource of 25.7 Mt grading 3.09 g/t for a total resource of 79,450 kg of contained gold (RBC Dominion Securities, 1997). In early February 1997, the Tanzanian Government granted a formal mining license to Resolute to develop a 2 million-ton-per-year (Mt/yr) mining and carbon-in-leach/carbon-in-pulp processing operation expected to produce over 5,600 kg of gold per year at a cost of $242 million (Resolute Ltd. 1997a,b). Construction was to start in March 1997 with commissioning scheduled for the first quarter of 1998.

The Bulyanhulu gold prospect of Sutton Resources Ltd. (Sutton), of Canada was the largest resource declination to date. Calculations based on drilling to December 31, 1996, increased the total identified gold resource to 10.5 Mt grading 14.92 g/t containing nearly 157 tons of gold. The estimate for Bulyanhulu Reef 1 included 1.39 Mt of measured resource grading 17.28 g/t; 5.37 Mt of indicated resource grading 15.67 g/t; and 3.04 Mt of inferred resource grading 13.29 g/t. The inferred resource at the Bulyanhulu Reef 2 was reported at 0.7 Mt grading 15.67 g/t. Underground development work was proceeding concurrently with exploration and would be used as a basis for a full feasibility study to be completed in early 1998. The initial production target anticipated processing 1,500 tons per day to produce up to 7,800 kilograms per year of gold ( Sutton Resources Ltd., 1997c).

Randgold Resources Tanzania, a joint venture between Randgold Resources of South Africa and Pangea Goldfields Inc. (Canada) was formed in September 1995 to explore the Golden Ridge project, which covers three adjacent areas of about 174 square kilometers in Lake Victoria gold fields, northwest Tanzania. Randgold has full management of the project and subject to expending $5 million on the project, completing a bankable feasibility study, and arranging project financing, could earn a 65% equity interest in the property. A prefeasibility study is expected to be completed on the project by July 1997. Rangold's 1996 exploration outlined three zones containing a total measured and indicated resource to 100 meters depth of nearly 50,000 kg of gold. The main resources at Golden Ridge were contained in two areas, Nyaligongo with 10.2 Mt grading 2.44 g/t and Hill 5 with 2.2 Mt grading 3.02 g/t (Pangea Goldfields Inc., 1997a). Pangea also held the rights to a number of other prospective gold properties, including joint ventures with Anglo American Corp. of South Africa on the Kahama/Chocolate Reef property where a resource of 10 Mt at 2.0 g/t containing 20,000 kg of gold had been identified to-date, and with Ashanti Goldfields Company. Ltd. (Ashanti) of Ghana on the Bulyanhulu South and Rubondo properties (Pangea Goldfields Inc., 1997b).

In early 1996, Ashanti acquired an 85% interest in the old Geita gold mine and adjacent exploration property in the Lake Victory Gold Belt through the acquisition of Cluff Resources plc. of the United Kingdom. Ashanti's exploration program focused on a 4-kilometer long northwest extension of the Lone Cone-Geita banded ironstone ridge (BIF) where drilling identified an indicated and inferred resource of 12 Mt grading 3.44 g/t, equivalent to 40,400 kg of gold. Fill in drilling will be done in 1997 with a feasibility study on the open pit potential of Geita to begin during the second-half of 1997 (Ashanti Goldfields Company Ltd., 1997).

In addition, East African Gold Corp., Princess Resources Ltd., Patrician Gold Mines in joint venture with JCI Ltd. of South Africa (which terminated in mid-1996), Tan Range, Serengeti Diamonds Ltd., and International Gold Exploration AB were also exploring for gold in Tanzania. East African Gold reported the identification of surface laterite and ironstone mineralization of 875,000 metric tons (t) gold at its Kitongo property with exploration continuing (East Africa Gold, 1996).

During the year, Sutton continued work in its two nickel-cobalt joint-venture projects with BHP Minerals International Exploration Inc., the Kabanga and the Kagera, in northwest Tanzania. Sutton reported total inferred resources at the Kabanga deposit of 31 Mt grading 1.5% nickel and 0.13% cobalt (Sutton Resources Ltd., 1997a). In early January 1997, BHP relinquished its interest in the Kabanga property, while obtaining a right to earn a 35% interest in the North Kagera nickel project, contingent on expenditures of $5 million. If a bankable feasibility study is completed, BHP's working interest will increase to 77.5% (Sutton Resources Ltd., 1997b). In a separate nickel market analysis, AME Mineral Economics of Australia indicated that the development of the very large Voisey's Bay nickel project in Labrador may lead to the delay or abandonment of marginal nickel projects such as in Kabanga, Tanzania, and in the Cote d'Ivoire (African Energy & Mining, 1996).

Other mineral production focused on diamonds, gemstones, and graphite. Williamson Diamonds Ltd., following an $8 million modernization, increased diamond production in 1996 to 117,000 carats from the Williamson (Mwadui) Mine. The company is owned 75% by De Beers Centenary Ag. and 25% by the State Mining Corp. Additional diamond exploration was being conducted by Reunion Mining of the United Kingdom at Mabuki while Serengeti Diamonds Ltd. of Canada, acquired an 80% interest in the Kahama diamond mining claim in 1995 from a local company, Tanzania Diamond Mines, which was verifying the resource potential of the property which had been estimated at some 400,000 carats. Serengeti also planned to commission a 50 ton-per-hour diamond processing plant at Kahama.

In 1996, SAMAX Ltd. of the United Kingdom transferred its management of the Graphtan Ltd. graphite mine, near Merelani, north Tanzania to Phoenix Minerals Ltd. The $20 million mine which began production in 1995, produced 6,776 t of graphite in its first full year of production in 1996.

In the energy sector, Tullow Oil of Ireland began evaluation of the offshore Mnazi Bay natural gas field; the Ocelot Energy Ltd. and Trans Canada Pipelines Ltd. Canadian joint venture, under contract to the Government, began development of the $300 million Songo Songo offshore gas production and processing project to deliver gas to a Dar es Salaam power station in 1998; and the World Bank was financing a $44 million rehabilitation of the Tazama oil pipeline from Dar es Salaam, Tanzania, to the Copperbelt in Ndola, Zambia.

## References Cited

African Energy & Mining, 1996, Tanzania/Ivory Coast—Doubts on nickel projects: African Energy & Mining newsletter, Paris, August 28, no. 187, p. 7.

Ashanti Goldfields Company Ltd., 1997, Annual Ashanti Goldfields report, 1996: Ashanti Goldfields Company Ltd., March 1997, 69 p.

East Africa Gold Corp., 1996, East Africa Gold Corporation to acquire further gold interests: East Africa Gold Corp. press release, Perth, Canada NewsWire Ltd., October 23, 3 p. (Accessed November 25, 1996, on the World Wide Web at URL http://www.newswire.ca/releases/October1996/23/c4224.html)

Pangea Goldfields Inc., 1997a, Pangea announces resource increase on the Golden Ridge project, Tanzania: Pangea Goldfields Inc. news release, Toronto, Canada NewsWire Ltd., January 28, 1997, 2 p. (Accessed March 2, 1997 on the World Wide Web at URL http://www.newswire.ca/releases/January1997/28/c4465.html)

———1997b, Recent diamond drill results confirm gold resource at Kahama: Pangea Goldfields Inc., news release, Toronto, Canada NewsWire Ltd., January 17, 2 p. (Accessed March 2, 1997, on the World Wide Web at URL http://www.newswire.ca/releases/January1997/17/c4465.html)

RBC Dominion Securities, 1997, Samax Gold Inc: Stock Analysis of RBC Dominion Securities Global Mining Team, January 24, p. 4 of 12.

Resolute Ltd. 1997a, 1996 Annual Report to Australian Stock Exchange (ASX), (Accessed March 2, 1997 on the World Wide Web at URL http://resolute-ltd.com.au/rsg96ar.htm)

———1997b, Golden Pride Mining License: Announcement to the ASX, February 6, 1 p. (Accessed March 2, 1997 on the World Wide Web at URL http://resolute-ltd.com.au/rsg0206.htm)

Sutton Resources Ltd., 1997a, Quick Facts: Sutton Resources Ltd. news release, Vancouver, January 23, 1 p.

———1997b, Sutton and BHP renegotiate nickel agreements: Sutton Resources Ltd, news release, Vancouver, January 15, 2 p.

———1997c, Sutton Resources Ltd. announces Bulyanhulu gold resource exceeds 5 million ounces: Sutton Resources Ltd. news release, Vancouver, February 20, 1997, (Accessed March 19, 1998, on the World Wide Web at URL http://www.suttonresources.com/)

## Major Sources of Information

Ministry Water, Energy and Minerals
P.O. Box 2000
Dar es Salaam, Tanzania
elephone: 255-51-31433/9
Fax: 255-51-44071

Geological Survey of Tanzania
P.O. Box 903
Dodoma, Tanzania
Telephone: 255-61-23281/5
Fax: 255-51-44071

Investment Promotion Centre
P.O. Box 938
Dar es Salaam, Tanzania
Telephone: 255-51-46848

## TABLE 1
## TANZANIA: PRODUCTION OF MINERAL COMMODITIES 1/ 2/

(Metric tons unless otherwise specified)

| Commodity 3/ | | 1992 | 1993 | 1994 | 1995 | 1996 e/ |
|---|---|---|---|---|---|---|
| Calcite | | 1,570 | 180 | 540 | 37 | 37 |
| Cement, hydraulic e/ | | 540,000 | 540,000 | 490,000 r/ | 800,000 r/ | 800,000 |
| Clays: | | | | | | |
| Bentonite e/ | | 70 | 70 | 70 | 70 | 75 |
| Kaolin | | 1,360 | -- e/ | 541 r/ | 596 r/ | 1,332 4/ |
| Coal, bituminous | | 71,121 | 51,270 | 45,000 r/ | 43,200 r/ | 52,000 4/ |
| Diamond 5/ | carats | 67,304 | 40,847 | 17,177 r/ | 49,538 | 126,670 4/ |
| Gemstones, precious and semiprecious excluding diamond | kilograms | 48,938 | 34,826 | 48,509 r/ | 111,403 r/ | 142,160 4/ |
| Gold, refined | do. | 3,201 | 3,264 | 2,861 r/ | 320 r/ | 318 4/ |
| Graphite | | -- | -- | -- | 359 | 6,776 4/ |
| Gypsum and anhydrite, crude | | 27,063 | 1,205 | 7,536 | 1,052 | 8,765 4/ |
| Lime, calcined and hydrated | | 1,806 | 356 | 101 | -- e/ | -- |
| Limestone, crushed | | 990,480 | 527,120 | 648,474 | 1,062,081 | 120,000 4/ |
| Mica, sheet | | (6/) | (6/) | (6/) | (6/) | (6/) |
| Petroleum refinery products: e/ | | | | | | |
| Liquefied petroleum gas | thousand 42-gallon barrels | 33 4/ | 30 | 30 | 30 | 30 |
| Gasoline | do. | 855 4/ | 850 | 850 | 850 | 850 |
| Kerosene | do. | 432 4/ | 400 | 400 | 400 | 400 |
| Jet fuel | do. | 262 4/ | 250 | 250 | 250 | 250 |
| Distillate fuel oil | do. | 820 4/ | 800 | 800 | 800 | 800 |
| Residual fuel oil | do. | 1,562 4/ | 1,500 | 1,500 | 1,500 | 1,500 |
| Other | do. | 450 4/ | 450 | 450 | 450 | 450 |
| Total including refinery fuel and losses | do. | 4,414 4/ | 4,280 | 4,280 | 4,280 | 4,280 |
| Phosphate minerals: | | | | | | |
| Apatite e/ | | 16,000 | 11,400 | -- | -- | 3,380 4/ |
| $P_2O_5$ content 7/ | | 4,948 | 3,541 | -- | 6,686 r/ | 717 4/ |
| Salt, all types | | 78,419 | 17,740 | 84,289 r/ | 105,000 r/ | 86,700 4/ |
| Sand, glass e/ | | 4,200 | 4,200 | 4,200 | 4,200 | 4,200 |
| Soda ash e/ | | 300 | 300 | 300 | 300 | 300 |
| Tin, mine output, Sn content | | 8 | 12 | 9 r/ | 3 r/ | -- |

e/ Estimated. r/ Revised.

1/ Includes data available through March 11, 1998.

2/ Estimated data are rounded to three significant digits.

3/ In addition to the commodities listed, modest quantities of unlisted varieties of crude construction materials (other clays, sand and gravel, and stone) presumably are produced, but output is not reported quantitatively, and available information is inadequate to make reliable estimates of output levels.

4/ Reported figure.

5/ Diamond figures are estimated to represent 70% gem-quality or semigem-quality and 30% industrial-quality stones.

6/ Less than 1/2 unit.

7/ $P_2O_5$ figures are reported and represent 31% of estimated apatite ($Ca_5Cl(PO_4)_3$) output. Consideration is given for impurities.

### THE MINERAL INDUSTRY OF

# TOGO

### By Philip M. Mobbs

Agriculture, phosphate mining, and regional trade continued to dominate Togo's economy. Output of phosphate rock continued its rebound from the strike-depressed production volume of 1993. In recent years, phosphate production and exports have accounted for 20% to 30% of export earnings, 10% to 13% of Government revenues, and 6% to 10% of the gross domestic product, respectively. The 100% Government-owned phosphate producer, Office Togolaise des Phosphates (OTP), remained Togo's largest foreign exchange earner and one of Togo's largest employers.

Law No. 96-004/PR was the Mining Code of the Republic of Togo. The code, promulgated during 1996, replaced a number of laws ranging from the 1924 licensing decree through Decision no. 008/MIMREH/MFE of 1979. Also during 1996, the Government proposed to divest 40% of its interest in OTP in 1997.

OTP operated the phosphate mines clustered around Hahotoe and Akoumape. The company's treatment plant and export terminal were at Kpeme, about 30 kilometers (km) from the mines. OTP recovered 1 metric ton of exportable phosphate rock for each 2 tons of raw ore processed at the Kpeme plant. Exports were shipped primarily to Canada, the Philippines, and South Africa. OTP was examining joint-venture beneficiation opportunities. The company was interested in building value-added phosphoric acid and fertilizer plants in Togo to process its phosphate instead of exporting rock.

In recent years, OTP experienced a decline in phosphate rock exports to its traditional Western European markets. European fertilizer producers were reducing the cadmium content of products generated from phosphate imports to less than 15 parts per million (ppm). Togo's high-grade (36% $P_2O_5$) phosphate ore averaged 40 to 50 ppm of cadmium (Phosphorus & Potassium, 1995).

Industry sources estimated that Togo had phosphate reserves of approximately 260 million metric tons (Mt), or about 130 Mt of exportable rock (U.S. Department of State, 1996). Besides phosphate rock for export and limestone for cement, exploitation of minerals in Togo was negligible. There was some artisanal recovery of diamond and gold.

Scancem International, a Norwegian/Swedish joint venture, increased its equity interest in Ciments du Togo (Cimtogo), a joint venture with the Government to 75% in mid-1996. Cimtogo, formerly a 50-50 joint venture, operated a 600,000-ton-per-year cement factory in Lomé. The plant used imported clinker.

The Government encouraged local and international participation in exploitation of its natural resources, but development of large-scale projects will require additional exploration and significant infrastructure improvements. The iron ore deposit near Bassar, which averages more than 40% iron, mainly as magnetite, has been studied periodically by the local Bureau National de Recherches Minières (BNRM) and most recently in conjunction with France's Bureau de Recherches Géologiques et Minières (BRGM) (Mining Magazine, 1984). In the past, the BNRM and BRGM exploration teams had sampled gold anomalies east of Bassar and had investigated diamond indications on the Akposso Plateau and in the surrounding alluvial basins, about 50 km north of Kpalimé. The exploration teams also had located chromite, rutile, and uranium mineralization in the northwestern part of the country. A number of smaller-scale mineral occurrences were known and were cited by the Government as potential artisanal or semi-industrial operations included aggregate, attapulgite, bentonite, brick clay, diamond, dolomite, glass sand, gold, limestone, marble, peat, phosphate, rutile, and dimension stone (Ministry of Mines, Energy, and Water Resources, 1995). In addition, the Ministry had documented barite, bauxite, garnet, gypsum, kaolin, kyanite, manganese, and monzanite occurrences.

Most of Togo's mineral requirements were imported through the Port at Lomé. Togo had long been a regional trade center, and its highway network facilitated trade between Lomé and Benin, Burkina Faso, and Ghana. All of the developed mineral deposits were accessible by the railway that connected Lomé with the cities of Anécho, Blitta, and Kpalimé. Exploitation of the iron, manganese, and phosphate deposits in the northern part of the country would require transportation improvements. Togo was expected to benefit from increased natural gas availability when the proposed West African Gas Pipeline from Nigeria to Ghana is constructed across southern Togo.

Togo's mineral economy is expected to continue to be dominated by the phosphate industry well into the next century. New industry attracted to the country by the Government's economic policies could provide an important economic buffer during periods of low phosphate prices. However, even with optimistic growth projections, the industrial sector is not diverse enough to isolate Togo from economic slowdowns when phosphate prices are low.

## References Cited

Ministry of Mines, Energy, and Water Resources, 1995, Togo mineral resources — Guide for mining investment in Togo: Lomé, Togo, 75 p.

Phosphorus & Potassium, 1995, The Cadmium Issue: Phosphorus & Potassium, no. 195, Jan.-Feb. 1995, p. 27-33.

U.S. Department of State, 1996, FY 1996 Country Commercial Guides (Gopher Archive Collection): (Accessed June 23, 1997 via the World Wide Web at URL http://www.state.gov/www/about_state/business/com_guides/)

## Major Source of Information

Ministère des Mines de l'Energie et des Ressources Hydrauliques
BP 12489
Lomé, Togo
Telephone: (228) 22-16-81
Fax: (228) 22-17-16

TABLE 1
TOGO: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

| Commodity 2/ | | 1992 | 1993 | 1994 | 1995 | 1996 e/ |
|---|---|---|---|---|---|---|
| Cement e/ 3/ | | 350,000 | 350,000 | 350,000 | 350,000 | 350,000 |
| Iron and steel, semimanufactures e/ 4/ | | -- | -- | 500 | 500 | 500 |
| Phosphate rock, beneficiated product: | | | | | | |
| Gross weight | thousand metric tons | 2,083 | 1,794 | 2,149 | 2,570 r/ | 2,731 5/ |
| P2O5 content e/ | do. | 760 | 540 | 800 | 930 r/ | 980 |

e/ Estimated. r/ Revised.
1/ Includes data available through June 23, 1997.
2/ In addition to the commodities listed, Togo presumably produced a variety of crude construction materials (clays, sand and gravel, and stone) but output is not reported, and available information is inadequate to make reliable estimates of output levels.
3/ Produced from imported clinker.
4/ Iron rod production from semifinished metal.
5/ Reported figure.

## THE MINERAL INDUSTRY OF

# TUNISIA

### By Bernadette Michalski

Petroleum production and processing, phosphate rock output with its derivative products, and base-metal mining formed the most important segments of the Tunisian mineral industry in 1996.

The laws governing hydrocarbon exploration and production were updated on June 12, 1990, by the Tunisian Parliament. This amendment, law No. 90-55, was designed to encourage foreign companies to engage in oil and gas exploration and development. The Government's hydrocarbon interests are overseen by the Enterprise Tunisienne d'Activités Pétrolières (ETAP), which maintained an interest in each licensed tract.

In the interest of accelerating privatization, foreign investors were permitted to buy up to 30% of Tunisian companies without prior authorization.

Appreciable increases in Tunisia's base-metals industry were reported in 1994 and 1995 with the commissioning of the Bougrine zinc-lead mine; however, mining operations at Bougrine were suspended in October 1996 (Metal Bulletin, 1996). The production of crude oil continued a slow decline in 1996. *(See table 1.)*

The European Union dominated Tunisian trade, accounting for 73% of total trade in 1996. France was Tunisia's main trading partner, accounting for about one-fourth of total trade followed by Italy accounting for nearly one-fifth of total trade. Imports totaled $7,588 million,[1] of which mineral and metal imports totaled $1,005 million. Petroleum imports alone were valued at $485 million. Exports totaled $5,406 million in 1996. The value of mineral and metal exports was $1,045 million, of which phosphate rock and its derivatives were valued at $537 million compared with $474 million in 1995. About one-third of Tunisia's export earnings is absorbed in debt servicing.

Phosphate rock extraction was entirely controlled and operated by the Government parastatal Compagnie des Phosphates de Gafsa, the largest company in Tunisia. Le Groupe Chimique Tunisien controls phosphate processing through its Tunisian-owned Société Industrielle d'Acide Phosphorique et d'Engrais and Société Arabe des Engrais Phosphates et Azotes. Société Minière du Nord-Ouest operated a lead-zinc-barite mine at Boujabeur and a zinc mine at Hassine. The parastatal Société du Djebel Djerissa produced iron ore from the underground mine at Djerissa and the open pit operations at Tamera and Douaria. Hydrocarbon exploration and production were overseen by a series of production-sharing agreements between foreign operators and the Tunisian Government-controlled ETAP, usually with ETAP holding a 45% to 50% equity.

The zinc-lead mine at Bougrine, approximately 170 kilometers (km) southwest of Tunis, commenced production in 1994 employing about 300 workers and operated by Société Minière de Bougrine, a subsidiary of Canada's Metall Mining Corp. The operation was an underground mine utilizing drift and fill and sublevel mining. Bougrine was the only private-sector mining project in Tunisia. Bougrine Mine concentrates were shipped to Germany for processing. Mining operations at Bougrine were suspended by investors in mid-October as zinc production costs were more than $0.50 per pound, while sales prices were $0.45 per pound.

Tunisian phosphate rock mining was primarily in the Gafsa region from a variety of open pit and underground sources. The increased cost of imported raw materials such as sulfur has appreciably reduced the profitability of phosphate derivatives. Sulfur imports totaled nearly 1.4 million metric tons (Mt) valued at $89 million compared with 1.3 Mt valued at $73 million in 1995.

Operated by the United Kingdom's British Gas Tunisia, the Miskar natural gas field came on-stream in May 1995. However, production at the Hannibal gas processing plant was shut down for the first 6 months of 1996 because of technical problems. By July, it was once again operative and by September it attained deliveries at its target rate of 4.5 million cubic meters per day ($Mm^3/d$) to the local power company (Middle East Economic Digest, 1996). The Trans-Mediterranean Pipeline (TransMed) delivering Algerian natural gas to Italy since 1983 supplied Tunisia between 600 and 800 $Mm^3/d$ of natural gas annually as a transit fee. The transit fees are expected to increase as further usage is made of the newly expanded TransMed.

Increased domestic consumption and declining output from larger oilfields continued to stress the hydrocarbon sector. The El-Borma Field operated by Italy's Azienda Generali Italiana Petroli (Agip) remained Tunisia's largest crude oil producer, output averaged more than 30,000 barrels per day (bbl/d). The offshore Ashtart Field operated by France's Société Nationale des Pétroles d'Aquitaine accounted for nearly 20,000 bbl/d as the result of a $210 million secondary development program.

An exploration agreement was signed in April 1996 between the Government and Agip of Italy for a 1,500-square-kilometer area in the Jenein block. The U.S. United Texas Petroleum is continuing its exploration program in the offshore Ramla block with a second well drilled in the last quarter of 1996. In order to concentrate on natural gas production, British Gas is offering for sale its 49% stake in the local Tunisian British Service which operates six producing oil fields.

Petroleum refining is confined to a single 35,000-bbl/d-capacity refinery at Bizerte, operated by the Société Tunisienne des Industries de Raffinage. The refinery output accounts for approximately one-half of the nation's petroleum product requirements.

---

[1] Where necessary, values have been converted from Tunisian dinars (TD) to U.S. dollars at a rate of D0.98=US$1.00.

Tunisian phosphate rock reserves are 3.5 billion metric tons to 4 billion metric tons, or about 5% of global reserves. Tunisian crude petroleum reserves are 410 million barrels. Reserves of natural gas are 30 billion cubic meters. The Inmet Mining Corporatio, reported minable reserves at Bougrine at 5.3 Mt grading 11.7% zinc and 2.6% lead (Inmet Mining Corporation, 1996).

A total of 2,260 km of railway was the primary mode of transportation of phosphate rock to chemical plants and seaports. Highways within Tunisia total 17,500 km. Crude oil pipelines are 797 km long, and natural gas pipelines total 742 km. Tunisia has an electrical generation capacity of about 1.5 megawatts. Combined cycle power stations, which generate electricity from natural gas, remained a construction priority.

The mineral industry is an integral part of the country's economic future. D Investments in heavy industry and a new export-directed economic policy combined with Tunisia's advantageous low labor costs and proximity to European and Middle Eastern market should enable Tunisia to evolve as a regional manufacturing center. Economic and technical cooperation with the members of the European community should substantially increase as Tunisia concluded an Association Agreement with the European Union in July 1995. The agreement provided for the creation of a free trade area for a 12-year period.

## References Cited

Metal Bulletin, 1996, Mining problems continue as Navan delays Spain's Mazarron zinc-lead-silver project: Metal Bulletin, no. 8136, December 9, p. 9.

Middle East Economic Digest, 1996, Oil and gas: Middle East Economic Digest, v. 40, no. 29, p. 15.

Inmet Mining Corporation, 1996, Annual report, 1996: Inmet Mining Corporation, p. 16.

## Major Sources of Information

National Office of Mines
Department de Geologie
95 Avenue Mohamed V
1002 Tunis Le Belvedere
Tunisia
Compagnie des Phosphate de Gafsa
Cité Bayech
Gafsa 2100
Tunisia
Société Tunisienne d'Expansion Minière
(SOTEMI)
Rue Mongi Slim
Le Kef, Tunisia
Entreprise Tunisienne d'Activités Pétrolières
27 bis, Avenue Khéereddine Pacha,
P.O. Box Tunis Belvédère, Tunis, Tunisia
Telephone: 216 1 782288
Fax: 216 1 784092

## Major Publication

Ministere du Developpement Economique
Institut National de la Statistique
Bulletin mensuel de Statistique
Monthly 1995-96
Tunis, Tunisia

## TABLE 1
## TUNISIA: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

| Commodity 2/ | | 1992 | 1993 | 1994 | 1995 | 1996 |
|---|---|---|---|---|---|---|
| METALS | | | | | | |
| Iron and steel: | | | | | | |
| Iron ore and concentrate, gross weight | thousand tons | 291 | 299 | 288 | 224 | 238 |
| Fe content | do. | 151 | 153 | 129 | 122 | 129 |
| Metal: | | | | | | |
| Pig iron | do. | 158 | 165 | 154 | 162 | 151 |
| Steel, crude | do. | 181 | 183 | 184 | 201 | 187 |
| Lead: Mine output, Pb content | | 1,362 | 863 | 2,856 r/ | 6,601 r/ | 4,764 |
| Silver metal, primary e/ | kilograms | 900 | 900 | 900 | 1,000 | 900 |
| Zinc, ore | | 4,090 | 2,389 | 23,379 | 80,446 | 58,044 |
| Zn content | | 2,310 | 1,350 | 13,000 | 44,244 | 31,920 |
| INDUSTRIAL MINERALS | | | | | | |
| Barite | | 30,179 | 15,289 | 15,732 r/ | 10,825 r/ | 15,360 |
| Cement, hydraulic | thousand tons | 3,999 | 4,269 | 4,606 | 4,998 | 4,566 |
| Clays, construction e/ | do. | 350 | 350 | 350 | 350 | 350 |
| Fertilizers: | | | | | | |
| Triple-superphosphate | do. | 783 | 651 | 830 | 818 | 844 |
| Phosphoric acid | do. | 864 | 858 | 986 | 1,018 | 1,093 |
| Diammonium-phosphate | do. | 680 | 749 | 741 | 830 | 928 |
| Ammonitrate | do. | 219 | 182 | 112 | 193 | 186 |
| Fluorspar, acid grade 3/ | | 13,750 | 1,399 | 676 | 1,856 | 1,856 |
| Gypsum e/ | | 100,000 | 100,000 | 100,000 | 100,000 | 100,000 |
| Lime e/ | thousand tons | 600 | 600 | 600 | 600 | 600 |
| Phosphate rock: | | | | | | |
| Gross weight | do. | 6,455 | 5,476 | 5,565 | 7,241 | 7,167 |
| $P_2O_5$ content e/ | do. | 1,890 | 1,630 | 1,712 | 2,181 r/ | 2,150 |
| Salt, marine | do. | 460 | 435 | 414 | 481 | 477 |
| MINERAL FUELS AND RELATED MATERIALS | | | | | | |
| Gas, natural: | | | | | | |
| Gross e/ | million cubic meters | 250 | 250 | 354 | 335 | 1,027 |
| Dry | do. | 200 | 200 | 250 | 250 | 800 e/ |
| Petroleum: | | | | | | |
| Crude | thousand 42-gallon barrels | 40,259 | 35,770 | 33,660 | 32,690 | 32,229 |
| Liquefied petroleum gas | do. | 1,648 | 1,460 | 1,545 | 1,465 | 1,573 |
| Gasoline | do. | 2,440 | 2,448 | 2,917 | 2,846 | 3,040 |
| Kerosene | do. | 1,183 | 1,141 | 1,057 | 1,035 | 1,012 |
| Distillate fuel oil | do. | 3,723 | 3,678 | 4,003 | 4,297 | 4,261 |
| Residual fuel oil | do. | 2,896 | 3,004 | 3,876 | 4,300 | 4,292 |
| Other e/ | do. | 400 | 400 | 448 | 568 | 551 |
| Total | do. | 12,290 | 12,131 | 13,846 | 14,511 | 14,729 |

e/ Estimated. r/ Revised.

1/Data available as of July 1, 1997.

2/ In addition to the commodities listed, a variety of crude construction materials (sand and gravel and stone) is produced, but output is not reported, and available information is inadequate to make reliable estimates of output levels.

3/ Zriba and Djedidi mines closed since 1992, all production from Boujabeur.

# THE MINERAL INDUSTRY OF

# UGANDA

## By Philip M. Mobbs

The contribution of Uganda's mineral production to the nation's primarily agricultural-based economy increased in 1996. Prior to the economic and political upheaval of 20 years ago, the Ugandan mineral sector had accounted for 30% of the gross domestic product (GDP). In 1994-95, the last year for which data were available, agriculture accounted for 47% of the GDP compared with the minerals sector's approximately 2% to 4%. However, given the Government's encouragement, the mineral sector was expanding rapidly.

Under the Constitution enacted on October 8, 1995, the Parliament was authorized to make laws regarding mineral production, royalties, and abandoned mine reclamation. The current mining law was the Mining Act of 1964. However, during 1996, a new mining code was being considered. The mineral industry was also regulated by the Investment Code, 1991 of January 25, 1991. The Uganda Investment Authority, the government agency responsible for investment promotion, operated a one-stop center to facilitate investment ventures. Uganda was also a member of the Multilateral Investment Guarantee Agency (Mining Journal (London), 1996).

The Central Bank's monopoly on gold purchases had been abolished in 1994. This action may have assisted gold exports reaching 5,067 kilograms (kg) in 1996 and 3,093 kg in 1995, compared with 225 kg in 1994 and 104 kg in 1993. Some of the increased gold exports may have been originally mined in Zaïre and brought into Uganda.

Mineral industry activities were administered by the Ministry of Natural Resources. The Department of Geological Survey and Mines in the Ministry's Directorate of Energy and Mineral Development issued mineral rights including prospecting licenses; exclusive prospecting licenses; location licenses; mining leases; mineral dealer licenses, such as precious metals dealer, diamond dealer, goldsmith, and mineral exporter; and water rights. The Department of Geological Survey and Mines also maintained a sizeable mineral-resource data base including concession, geologic, geochemical, geophysical, and topographic maps.

The Government was also interested in having private investors reopen closed mines, such as the Kilembe copper mine, the Sukulu phosphate operations, the Kikagati tin mine, the Mwerasandu tin mine, the Bjordal tungsten mine, the Kirwa tungsten mine, and the Ruhija tungsten mine (Onyango, 1997). Additional Ugandan mineral resources reported to have the potential to attract commercial investment include diatomite, dimension stone, iron ore, gold, gypsum, mica, nickel, phosphate, salt, and vermiculite (Hester and others, 1996). Many deposits had been the sites of small-scale operations prior to the 1980's.

Small-scale mining activity was encouraged especially for beryl and columbite-tantalite in the pegmatites in the southwest. The Ministry, faced with an expanding demand for construction material, was appraising the nation's industrial minerals resources. Government policies included the promotion of private investment in the mineral industry, environmental protection, and advocating the technical and managerial development of the current and potential mineral industry workforce (Sendaula, 1997).

Mineral operations were primarily in the southeast and southwest of the country. Exclusive prospecting licenses (EPL's) were staked all over the country. However, in the north and northwest, there was an active antigovernmental rebellion underway, significantly impeding exploration activity. The region was subject to aerial bombing raids from Sudan (Ugandanews, 1996). The Lord's Resistance Army, long regarded by the Government as a minor local annoyance, swarmed into Uganda from rebel bases in Sudan during February 1996. By midyear, road traffic into Gulu began to travel in convoys with military escort. The West Nile Bank Front returned to the northwest from encampments in Sudan and Zaïre. Landmines were becoming ubiquitous. Additional frontier region attacks were mounted by Salaf Tabliq Islamic militants and operating in the border region near Kasese were the Allied Democratic Forces, a rebel organization encompassing the groups mentioned above along with former Zaïrean Army, Burundi, and Rwandan personnel (United Nations, 1996).

In the northeast near Kaabong, the exploration trenching on Branch Energy (Uganda) Ltd.'s gold concession became embroiled in Karimojong clan politics. Some pastoral clans protested that the Government had effectively surrendered their wealth to foreigners, resulting in an inconclusive September 1996 investigation of Branch Energy (Uganda)'s operations by a Parliament committee. Branch Energy (Uganda) was not affiliated with the company Branch Energy Ltd. that was acquired by DiamondWorks Ltd. of Canada in October 1996 (Info-Mine, 1996).

Fifty companies held 125 EPL's or special exclusive prospecting licenses (SEPL's) including Branch Energy (Uganda); Glencar Explorations plc of Ireland; International Roraima Gold Corp., a subsidiary of Roraima Mining Co. Ltd. of Canada; Nickelfields Ltd., a subsidiary of Pacific Vangold Mines Ltd. of Canada; Pangea Goldfields (Uganda) Ltd.; Rift Resources Ltd. of Canada; and Tusker Exploration Ltd. Gold exploration permits accounted for 80% of the outstanding EPL's and SEPL's at yearend 1996.

Twenty-two operators held 59 location licenses (mining licenses for small-scale operations). However, one company alone held 25 iron ore licenses. Thirteen location licenses had been issued for gold production. Crude construction mineral production such as brick clay, sand, and stone did not require a license from Department of Geological Survey and Mines.

Ten companies held 13 mining leases with almost 40% of the leases designated as limestone extraction operations. There were three tin mining leases, one copper/cobalt mining lease, and one gold mining lease at yearend.

The Shumuk Group launched Uganda's entrance into the secondary aluminum market with the opening of the Shumuk Aluminum Rolling Mill in Kampala during 1996. The mill would allow scrap aluminum, traditionally exported to Kenya, to be remelted and processed in Uganda. However, the 4,200-metric-ton-per-year (t/yr) capacity plant had not started production by yearend.

Financing for the Kasese cobalt project was secured during 1996. The project, to be operated by Kasese Cobalt Co. Ltd. (KCCL), proposed to recover cobalt from Kilembe Mine concentrates stockpiled near the Kasese railhead in southwestern Uganda. Kasese Cobalt Co. was a joint venture of Banff Resources Ltd. of Canada and the state-owned Kilembe Mines Ltd. Estimated to cost $110 million, the project was to be funded by Banff; Banff's majority stakeholder, La Source Group of France; and Kilembe Mines, and supplemented by financing by the European Investment Bank; the International Finance Corp.; and Proparco of France. Commonwealth Development Corp., an original member of the financial consortium, withdrew its support in December 1996.

Construction of the KCCL plant was scheduled for mid-1997. Bioleaching of the concentrates, solvent extraction, and electrowinning were not expected to begin until 1998. Plans were to process approximately 820,000 metric tons of concentrates assaying 1.38% cobalt to recover approximately 1,000 t/yr of cobalt cathode. Operations were expected to extend over an 11- to 12-year period, generating approximately 5% of world cobalt production annually and placing Uganda among the top 10 cobalt producers of the world. KCCL was also preparing a 90,000-t/yr limestone quarry and studying the reopening of the original Kilembe Mine, in which Banff had 65% interest.

Gold was recovered by artisanal miners in the northeast and along the western border. There had been a significant increase in international exploration activity since the United Nations Development Programme's (UNDP's) Mineral Investment Promotion began in 1992. International Roraima had acquired 20 EPL's. Exploration activity during 1996 included geologic mapping, soil sampling, geophysical surveys, and trenching. Seventeen of the permits were ventures with ISCOR Ltd. of South Africa.

The financial problems of GHK Resources Ltd. of Canada resulted in slower than expected exploration activity on nickel EPL 4150, adjacent to the Kilembe sulfide belt. In December, Pacific Vangold optioned three permits from GHK, including EPL 4150. Pacific Vangold drilled the Kafunzo nickel-cobalt prospect in southwestern Uganda and also authorized B.A.S.M. Resources Corp. of Canada to explore on EPLs held by Pacific Vangold's local subsidiaries, Equatorial Resources Ltd. and Nickelfields.

The Government (51%) and the Madvhani Group of Uganda (49%) were working toward a 1997 recommissioning of the 25,000-t/yr-capacity Steel Corp. of East Africa Ltd. in Jinja. The Steel Rolling Mills, a 21,000-t/yr-capacity electric arc steelworks in Jinja was having problems obtaining scrap feed. Downstream steel operations in Uganda include BM Technical Services in Mbarara, a 20,000-t/yr-capacity rolling mill and the Sembule Steel Mills in Kampala, a 20,000-t/yr-capacity rolling operation.

The Rawal Group of Industries had acquired the Government's Uganda Cement Industries cement plant in Hima during 1994. The Rawal Group began the renovation of the electrostatic precipitator in 1996 to reduce dust emission at the renamed Hima Cement Industries. The company planned to continue production from the 600-metric-ton-per-day (t/d) capacity No. 2 line after the refractory lining was replaced. Refurbishment of the 300-t/d-capacity No.1 line, out of production since a fire in 1979, was proposed for 1997.

In November 1996, Rawal Group notified the government that it considered the limestone reserves sold with the cement plant to have been significantly smaller than represented in the sale documents. Based on the alleged misrepresentation, Rawal Group indicated its unwillingness to pay the balance of approximately $5.5 million[1] owed to the Government for the plant. Additionally, the armed conflict in eastern Zaire threatened the market for about 15% of the company's sales.

During December 1995, the state-owned Uganda Cement Corp.'s Tororo plant was purchased by Corrugated Sheets Ltd. of Mombassa, Kenya. As Tororo Cement Industries, the overhauled mill was grinding clinker brought in from Hima or imported from Tanzania. A 750-t/d-capacity kiln was proposed for restoration.

The proposed development of the Sukulu phosphate (apatite) resource near Tororo estimated by the Government to contain 300 million metric tons of phosphate at an average grade of 13.1% $P_2O_5$ was deferred. Gujarat State Fertilizers Co. Ltd. of India (GSFC) and the state-owned Uganda Development Corp. had planned to construct a 200,000-t/yr-capacity triple superphosphate fertilizer plant at Tororo. However GSFC withdrew reportedly after a study indicated that the envisioned project was not feasible (The Monitor, 1997).

The Uganda People's Defense Forces, the government's military branch, operated National Enterprises Corp's Lime Dura. During 1996, the 2,400-t/yr-capacity hydrated lime producer was seeking funding to expand its 3-quarry mining operation.

The formation of Uganda Salt Enterprises Ltd., a joint venture of Israeli Salt Enterprises Ltd. (75%) and the Uganda Development Corp. (25%) was announced in May 1996 (Nabeta, 1996). Uganda Salt proposed to process imported salt to produce 80,000-t/yr iodized salt at a plant near the Namanve railroad station, northeast of Kampala. Uganda Salt also commissioned a feasibility study of producing salt from Lake Katwe. However, Uganda Development Corp. was having difficulty securing government funding for the joint venture. Additionally, the Kasese district government and the Lake Katwe town Africa also had important production of a number of secondary or processed mineral commodities, notably

---

[1] Where necessary, values have been converted from Uganda shillings (USh) to U.S. dollars at the yearend rate of USh1017=US$1.00.

The East African Glass Works renovation was expected to stimulate the local demand for silica sand. The rehabilitation of the bottle plant by Muljibal Madhvani & Co. Ltd. was funded by a loan from the African Development Bank.

During March 1996, the Government canceled the production sharing agreement it had on Block 2 in the southwest of the country with Uganda General Works and Engineering Corp. (UGWEC), an affiliate of the International Resources Development Group of the United States. UGWEC had been unable to finance the exploration program originally scheduled to start up in June 1995. In December 1996, the concession was awarded to Heritage Oil and Gas Ltd., a London-based, Bahamian company.

The Government's Road Sector Development Program was initiated in 1996. This 10-year $1.5 billion project was intended to reconstruct 4,000 kilometers (km) of road and repair the nation's 30,000-km road network, positioning Uganda as a transportation conduit for Central African trade. Roads were emphasized in lieu of the railroad because of the lack of international financing available. The aging rolling stock and track of the Uganda Railways Corp. resulted in increased maintenance expenses. The railway connected Kasese, Kampala, and Tororo with the port of Mombassa, Kenya, and there was a rail ferry from Port Bell, near Kampala to Mwanza, Tanzania, with connections to Dar Es Salaam, Tanzania.

With its booming economy, Uganda had been subject to electric power deficits since the early 1990's. In addition to domestic demand, the Uganda Electricity Board (UEB) was saddled with a long-term contract to supply 30-megawatts (MW) to Kenya. Power was generated by the 160-MW-capacity Owen Falls hydroelectric dam, supplemented by smaller generation facilities near Kabale and the rehabilitated 10-MW Mubuku hydroelectric power station near Kasese in the southwest. UEB also obtained power from diesel plants near Arua, Kampala, Kitgum, Mbale, Moroto, Moyo, and Nebbi.

The Chinese company SIETCO had been awarded the Owen Falls II contract in 1992. The project proposed to expand the Owen Falls plant from 160 to 180 MW and construct a 102-MW hydroelectric station downstream from the Owen Falls Dam by 1997. In 1996, the project completion date had slipped to 1999, and in September the UEB removed SIETCO as project manager.

Nile Independent Power Co., a joint venture of AES Corp. of the United States and Madhvani International of South Africa agreed to build a privately owned 290-MW hydroelectric generating plant on the Victoria Nile (The Indian Ocean Newsletter, 1997). Construction was not scheduled until 1997and power was not expected to be available to the Uganda grid until 2003.

Uganda has a rapidly expanding economy, despite the unrest in the Central African region and the rebellion in northern Uganda. Its mineral resources are relatively under explored and underdeveloped.

The Mineral Development Promotion Program ended in June 1996. The program had been set up with UNDP's assistance during 1992 to assist with mineral information dissemination and to facilitate the development of the nation's numerous, but relatively small mineral occurrences. A legacy of the program is that Ugandan mineral industry is expected to continue to diversify through the turn of the century. Increases in mineral exports and mineral industry activity should augment the country's foreign exchange revenues and attract additional international interest and investment in the nation's mineral industry. However, further growth of energy-intensive mineral processing may be limited during the next 5 to 6 years by the UEB's power problems.

## References Cited

Hester, Brian, Boberg W., and officers of the Department of Geological Survey and Mines of Uganda, 1996, Uganda, opportunities for mining investment: Brian W. Hester Inc., Denver, Colorado, 57 p.

Info-Mine, 1996, December 13, 1996: The Daily Prospector, (Accessed December 13, 1996 on the World Wide Web at URL http://www.info-mine.com/daily.news/dp_dec13-96.html).

The Indian Ocean Newsletter, 1997, Uganda—Three American projects: Paris, The Indian Ocean Newsletter, no. 775, July 12, 1997, p. 6.

Mining Journal (London), 1996, country supplement, Uganda, Renaissance in mining: v. 326, no. 8373, April 12, 16 p.

The Monitor, 1997, Govt backs out of giant phosphate deal: Kampala, Uganda, The Monitor, April, 15, 1997, (Accessed July 17, 1997, on the World Wide Web at URL http://www.africanews.com/monitor/).

Nabeta, Loy, 1996, Israeli company to start Shs 14bn salt factory in Namanve: Kampala, Uganda, The Monitor, Kampala, Uganda, May, 1, 1996. (Accessed January 9, 1997, on the World Wide Web at URL http://www.africanews.com/monitor/).

Onyango, Patricia, 1997, The New Uganda trade and investment opportunities, mining sector profile: Uganda Investment Authority, Kampala, Uganda, January, 12 p.

Sendaula, Gerald, 1997, Uganda: Paper presented and distributed at the 4th Multilateral Investment Guarantee Agency Mining Symposium, Denver, Colorado, June 3-5, 1997, 10 p.

Ugandanews, 1996, Uganda vows to avenge bombing: Kampala, Uganda, Ugandanews, September 24, 1996. (Accessed November 15, 1996, on the World Wide Web at URL http://www.africanonline.com/AfricaOnline.cgi/postnews.cgi?960924+ugandanews).

United Nations, 1996, Uganda—Humanitarian situation report on Uganda (12/04): United Nations Department of Humanitarian Affairs, Nairobi, Kenya, December 4, 8 p. (Accessed January 28, 1997, on the World Wide Web at URL http://www.reliefweb.int/emergenc/greatlak/source/dha/ugan_sr/041296.html).

## Major Sources of Information

Permanent Secretary
Ministry of Natural Resources
P.O. Box 7270
Kampala, Uganda
Telephone: (256) (41) 234-733
Fax: (256) (41) 230-220
Uganda Investment Authority
The Investment Centre
Plot 28, Kampala Road
P.O. Box 7418
Kampala, Uganda
Telephone: (256) (41) 251-562, 234-109
Fax: (256) (41) 342-903

## TABLE 1
## UGANDA: PRODUCTION OF MINERAL COMMODITIES 1/ 2/

(Metric tons unless otherwise specified)

| Commodity | | 1992 | 1993 | 1994 | 1995 | 1996 e/ |
|---|---|---|---|---|---|---|
| Cement, hydraulic | | 50,000 e/ | 50,000 e/ | 42,000 r/ | 85,000 r/ | 150,000 |
| Columbium-tantalum | kilograms | 35 | 452 | 435 | 1,842 | 2,000 |
| Gold | do. | (3/) r/ | 291 r/ | 1,627 r/ | 1,506 r/ | 2,954 4/ |
| Gypsum | | 396 | 308 | 201 | 1,538 | 3,000 |
| Iron ore | | 33 r/ | -- r/ | -- r/ | 7 r/ 4/ | 200 4/ |
| Lime, hydrated and quick | | 100 r/ | 1,024 r/ | 163 r/ | 970 | 1,000 |
| Limestone e/ | | 45,000 | 46,000 | 38,000 | 78,000 | 135,000 |
| Phosphate minerals, apatite | | -- r/ | -- r/ | -- r/ | 20 r/ | -- 4/ |
| Salt, evaporated | | 10 r/ | 10 r/ | 10 r/ | 10 r/ | 10 |
| Steel | | 20,000 | 20,000 | 10,000 | 12,000 | 12,000 |
| Tin, mine output, Sn content | | 2 r/ | 3 r/ | 3 r/ | 43 r/ | (3/) 4/ |
| Tungsten, mine output, W content | | 16 r/ | 5 r/ | 12 r/ | 17 r/ | -- 4/ |

e/ Estimated. r/ Revised.
1/ Includes data available through July 31, 1997.
2/ In addition to the commodities listed, the following are presumably produced but information is inadequate to estimate output: clay, copper content of slag, corundum, garnet, gemstones, gravel, kaolin, ruby, sand, and vermiculite.
3/ Less than 1 unit.
4/ Reported.

### THE MINERAL INDUSTRY OF

# ZAIRE

### By George J. Coakley

In 1996, the mining industry of Zaire continued to stagnate. Historically, the mining industry accounted for 25% of Zaire's gross domestic product and about three-quarters of total export revenues. However, the near collapse of the economy has made it difficult to sustain normal mining activities. The outbreak of fighting late in the year in eastern Zaire between Army troops and Tutsi rebels put further pressure on the Government and the economy, already burdened with half a million refugees fleeing the civil wars in Rwanda and Burundi. The state-owned La Generale des Carrieres et des Mines du Zaire (Gecamines), formerly the nation's major foreign currency export earner, continued to struggle to maintain copper production at only 5% of capacity. A program begun in 1994 to focus on high unit value cobalt production gave some returns as cobalt mine production increased 19% in 1996 and refined cobalt increased by over 20% in 1996 from 1995 levels.

The deterioration of the overall economy of Zaire and the lack of reinvestment of Gecamines revenues in routine maintenance and capital development have contributed to this decline in the industrial mainstay of the economy. With the virtual collapse of Zaire's metal mining sector, diamond exports, chiefly from the Kasai Provinces, became Zaire's most important source of foreign exchange derived from the mineral sector. Hyperinflation and the further disintegration of the economy continued in 1996 as the internal economies of the key mining Provinces of Kivu and Kasai, and Shaba operated almost independently of support from the central Government. The national economy was also adversely affected by the massive influx of Rwandan refugees into the country near Goma that affected the northeast region's gold and columbium (niobium) production.

Legislation existed relating to all aspects of the mineral industry. Article 10 of the Constitution stated that the soil and subsoil belong to the state. Prospecting, exploration, and exploitation were regulated by Ordinance No. 81-013 of April 2, 1981, and required permits from the Ministry of Mines and Energy.

The Zairian Government through the Ministry of Mines, which controls most of the mining enterprises, had set in motion, at the encouragement of the World Bank, efforts to privatize the mining sector and to attract new foreign investment through joint ventures with Gecamines. Targets for privatization or joint-venture redevelopment were the more than 20 copper-cobalt and zinc mines and processing facilities owned by Gecamines, the gold-tin producer Societe Miniere et Industrielle du Kivu (SOMINKI), the major diamond producer Societe Miniere de Bakwanga (MIBA), and the major gold producer Office des Mines d'Or de Kilo-Moto (Okimo).

Gecamines faced multiple crises in finance, production, and transportation. The company's poor condition was attributed to a combination of aging equipment; lack of domestic and international investment; lack of spare parts; fuel, lubricants, and sulfuric acid shortages; ore and finished product transportation problems; theft of finished products; debts owed to the state electricity company and state railway company; flooding of open pit mines; and the inability to retain professional and other personnel because of disruptions caused by tribal conflicts and other factors.

Gold production declined an estimated 18% while diamond production by MIBA and artisanal miners continued to thrive but reportedly as much as one-third or 6 to 7 million carats of national output was smuggled out of the country (Mining Journal, 1996). *(See table 1.)*

The more significant mineral commodities exported from Zaire were cobalt, copper, diamond, gold, and crude oil, of which 5.5 million barrels went to the United States. Zaire's main trading partners were Belgium, France, Germany, Japan, South Africa, and the United States. Imports by the United States from Zaire consisted mainly of refined copper cathode, gem diamond, and crude oil.

Zaire's Government maintained at least part ownership, and generally majority ownership, of nearly all the productive and service sectors of the economy. Gecamines, the principal parastatal company, produced essentially all of Zaire's copper, cobalt, and coal. Gecamines also operated subsidiaries that produced cement and other materials required for its primary mineral interests. MIBA, which is 80% owned by the Government produced about 25% of industrial diamond production with the remainder coming from small artisanal operators. Sominki and Okimo were the other principal parastatal mining companies.

Under Gecamines survival plan, cobalt became the company's primary foreign currency earner. Zaire's total cobalt metal production continued to recover from an estimated level of 3,300 metric tons (t) in 1994 to approximately 3,990 t in 1995, of which 546 t were semifinished white alloy and matte.

In 1995, Gecamines reported completion of an investment of $130 million to put in a 20-million-cubic-meter-per-year, 15-kilometer (km) conveyor belt extraction system at the Kamoto Oliveira Virgure (KOV) open pit mine at Kolwezi. Union Miniere (UM) of Belgium entered a joint venture with Gecamines to rehabilitate the Kasombo cobalt mine and upgrade hydrometallurgical process at the Shituru cobalt plant near Likasi. Mine production began in September 1996 with 1,000 t of cobalt produced in the last quarter. The cobalt plant was expected to be operational in early 1997, increasing cobalt recoveries by several hundred tons per year. In 1996, UM Cobalt and Energy products also acquired 28,000 t of stockpiled low grade cobalt hydrates containing some 1,000 t of cobalt for export.

In late 1995, Gecamines awarded a $41-million contract to JCI Ltd. of South Africa to upgrade mining equipment and metallurgical facilities. Indications were that Gecamines was making a concerted effort to begin to restore copper production capabilities through modest new investment and through new efforts to seek joint-venture foreign investment participation. Despite the perceived high political risk, the known high grade copper-cobalt resources and basic in-place mining infrastructure began to attract some international mining companies.

In November 1996, the Canadian company, Consolidated Eurocan Ventures Ltd., a subsidiary of Lundin Holdings Ltd. of Bermuda, acquired from Gecamines a 55% interest in the Tenke-Fungurume copper deposits. Gecamines will retain a 45% equity interest and receive compensation payments from Consolidated Eurocan Ventures Ltd. of $50 million by December 1996; $40 million "when Consolidated Eurocan elects to place project into production;" and a final payment of $160 million by December 2002. Geological resources, dating back to when efforts were made to develop the property in the 1970's, were reported by the company at 222 million metric tons (Mt) at 4.42% copper and 0.33% cobalt of which proven reserves equal 92.6 Mt of 4.59% copper and 0.36% cobalt. To put the high copper ore grade of the Tenke-Fungurume deposits, and the low unit cost potential of this project, in perspective it is over 8 times richer than the average grade of copper ore mined in the United States of 0.57%. A $12 million feasibility study was scheduled to begin in April 1997. (Consolidated Eurocan Ventures, 1996a,b; Metal Bulletin, 1996b, 1997; Randol International, 1996 ). In January 1997, Consolidated Eurocan Ventures changed its corporate name to Tenke Mining Corp.

The junior exploration company, International Panorama Resources Corp. of Canada acquired a 51% working interest from Gecamines in August 1996 to reprocess copper-cobalt tailings from the Kambove and Kakanda Mines. Gecamines also was to receive 1.5% net profits royalty after the capital payback period. Estimated resources in the tailings were 61 Mt averaging 0.98% copper and 0.19% cobalt. International Panorama Resources estimates 85% of resource will be recoverable over a 10 to 13 year project life. A feasibility study is to be conducted in 1997. Preliminary capital development costs were projected at $190 million, with production startup projected for mid-1999 (International Panorama Resources, 1996a,b,c).

Anvil Mining of Australia completed negotiations in September with the Government of Zaire on the terms of a mining convention in which Anvil would acquire a 90% interest in the Dikulushi copper-silver project in southeastern Zaire near the Zambia border west of Pweto and Lac Moero. Anvil reported a measured and indicated resource at Dikulushi of 1.66 Mt grading 11% copper and 310 grams per metric ton (g/t) silver. The mining convention was signed in January 1997 (Anvil Mining, 1997).

In January 1996, Banro Resource Corp. of Canada, through its wholly owned subsidiary, African Mineral Resources Inc., in conjunction with its joint-venture partner, Mines d'Or du Zaire (MDDZ) purchased a 64% interest in SOMINKI for $3.5 million. Banro and MDDZ jointly controlled 72% of the gold, tin, tantalum mines and land of SOMINKI with the balance retained by the Government. The company owns 10 mining permits and 47 mining concessions covering 10,271 square kilometers. Included in the gold holdings southwest of Bukavu in Kivu Province are the producing Kamituga/Mobale underground gold mines which Banro estimates, based on past work by SOMINKI, to contain resources of 124,414 kilograms (kg) of contained gold; the Twangiza property containing proven and probable open pit oxide reserves of 5.5 Mt grading 4.3 g/t, with possible minable sulfide reserves of 2.7 Mt containing 4,600 kg of gold; the Lugushwa property containing resources on two of its areas of 3 Mt of 4.5 g/t and 2.5 Mt of 4 g/t respectively; and the former Namoya Mine with reported mineable sulfide reserves estimated at over 9,330 kg of contained gold. In January 1997, Banro signed a new mining convention with the Government increasing Banro's interest in SOMINKI to 93% with the Government retaining a 7% carried interest. At the same time, all assets of SOMINKI were transferred into a new company, SAKIMA SARL. Banro agreed to invest $15 million and received a 10 year-post production tax moratorium, an elimination of import duties, and the right to export all gold production (Banro Resource Corp, 1996, 1997).

In August 1996, the Barrick Gold Corp. of Canada signed a mining convention with the Government to explore and operate the former state-owned Okimo gold mines in the Bunia area in northeast Zaire (Africa Energy & Mining, 1996).

The Kisenge Manganese Company has not done any mining since the late 1970's when the civil war in Angola closed the Benguela railroad, Kisenge's principal export route. At that time, an estimated 1 Mt of manganese ore was stockpiled at the mine site. Some ore has been shipped internally to supply a dry cell battery plant, but it is believed that most of the stocks remain. In October 1995, Kisenge signed a contract with the Benatar Group of South Africa to ship an initial amount of 10,000 to 15,000 t, most likely via the Tazara Railroad to the port at Dar es Salaam, Tanzania. A further shipment of 100,000 t was also discussed that would provide Kisenge with the capital to upgrade its battery plant (Yenga, 1996).

American Mineral Fields Inc. (AMF), a company headquartered in the United States and listed on the Vancouver Stock Exchange, signed a framework agreement with Gecamines effective August 20, 1996, to procure a feasibility study on the Kipushi zinc mine and related facilities. AMF can only acquire an equity interest if a successful feasibility study leads to another agreement with Gecamines to rehabilitate the mine and smelter which closed in 1993. AMF also entered a 50-50 joint venture with the Anglo American Corp. of South Africa on May 8, 1996 to conduct the Kipushi feasibility study (Financial Times, 1996). Preliminary estimates by AMF projected a cost of $30 million to renovate mine and mill. A feasibility study on building a smelter to produce 200,000 metric tons per year (t/yr) of zinc; 30,000 t/yr of copper; and 400,000 t/yr sulfuric acid was underway. Capital costs for the smelter were projected around $350 million. An AMF consultant, Watts, Griffis and McOuat of Canada confirmed Gecamines estimates of remaining measured resources at 9.9 Mt at 2.51% copper, 0.47% lead, and 9.96% zinc. Combined measured and indicated mineral resources are 20.6 Mt at 2.27%

copper, 0.47% lead, and 15.18% zinc. Minable proved and probable reserves, after 10% dilution, were given as 22.6 Mt at 2.06% copper, and 13.81% zinc. An addition indicated mineral resource of approximately 16 million cubic meters of Kipushi tailings grades an average 0.36% copper, 1.62% lead, and 2.25% zinc (American Mineral Fields, 1996; Metal Bulletin, 1996a).

MIBA was the major official diamond producer in Zaire, accounting for about 40% of official Zairian diamond exports. MIBA is owned 80% by the Government and 20% by the Belgium company Sibeka, in which De Beers has a minority interest. De Beers purchases all of MIBA's industrial diamond output under an exclusive contract. In 1996, MIBA mined 4.2 MT of ore in 1996 and with the help of new crushing, washing and sorting plant recovered 5.5 million carats with an average value of $12 per carat (World Diamond Industry Directory & Yearbook, 1997/1998). In 1996, in addition to MIBA, 11 official diamond buyers and exporters (comptoirs) exported an estimated 1 million carats per month valued at approximately $30 million. The Government's Centre National d'Expertise estimated that more than one-third of Zaire's diamond production worth about $300 million is smuggled out each year (Mulenga, 1997; Mining Journal, 1996). Three Canadian companies, South Atlantic Diamonds, Taylor Rand, and White Swan Resources Inc. were actively exploring for diamonds in the Kasai Provinces during the year. The flight of rebel Unita troops across the Angola/Zaire border into diamond producing areas in Kasai was also disruptive to artisanal mining activities.

Coal production from the Luena Mine was significantly reduced as a result of ethnic conflicts in Shaba and the reduced demand from Gecamines' plants.

Zaire Gulf Co., which is controlled by Chevron (United States—50%), Teikoku Oil (Japan—32.3%), and Unocal (United States—17.7%) produced approximately 75% of the nation's petroleum from its 35 offshore wells.

Zaire's major mineral resources were generally considered sufficient for many years of production, with known copper ore grades running two to eight times the grade of typical copper ore mined in North America and South America. However, reserve data on copper, cobalt, gold, and zinc have not been updated for several years and must be reevaluated in light of current economic conditions in Zaire and in light of the deterioration of Gecamines and other facilities. Reserves of oil and gas at yearend 1995 were 187 million barrels of oil and 1.4 billion cubic meters of natural gas (International Petroleum Encyclopedia, 1996).

Zaire is an essentially landlocked country, with only a small coastal area on the Atlantic Ocean. The 2-million-metric-ton-per-year Port of Matadi suffered from abysmal road access to the interior, endemic looting, and an 160-km river approach to the seaport and has been subject to periodic Angolan rebel attacks (Journal of Commerce, 1994). Water falls make the Congo River unnavigable below Kinshasa and limit the world's second largest river as a significant export route.

Zaire utilized a combination of railroad, road, and river boat transport to move equipment, food, and other supplies into the mining and mineral processing regions and to convey out ores, concentrates, and finished mineral products. Much of this transport network was in varying degrees of disrepair. Locomotive and rolling stock shortages continued to limit the availability of ore at the mills, as well as limiting the quantity of finished products available for export. The Sizarail line was a critical logistical support link for the diamond industry between the Zambian border and Mubuji-Maya.

The major companies involved in transportation are Government owned. Small private trucking and river boat companies provided limited local service. Mineral products were shipped at times from the Copperbelt west on the Voie Nationale, a difficult road-rail-water route, to the Matadi seaport, the only transport route entirely within Zaire; through Zambia on the Tazara railroad to the Port of Dar es Salaam in Tanzania; as well as through Zambia to southern rail lines leading to bulk loading export ports in South Africa. Copper shipments could take 45 days to get from the plant to the dock, either south via Zambia and Zimbabwe or eastward along the Tazara railway. Owing to rail and river transport problems, most cobalt and copper wirebar products were shipped via truck convoy to the Port of Durban in South Africa. High-value cobalt, diamonds, and gold can be flown out of the country.

Shaba Province, the site of most of the country's mining activity, historically consumed almost 50% of the nation's generated electrical power. A portion of the electricity used in the Shaba region was delivered by the 1,800-km long, 560-megawatt Inga-Shaba transmission line, which runs from the Inga Dam on the Congo River south of Kinshasa to the Copperbelt city of Kolwezi in Shaba Province. Nevertheless, the tremendous hydroelectric potential of the Congo River remains largely untapped. Gecamines was also dependent on imported coke and refined petroleum products for its mine and metallurgical operations.

The short-term economic prospects for Zaire were poor and were further threatened by refugee problems and fighting in eastern Zaire. The recent decline of copper and cobalt production had led to the deterioration of the country's most important company, Gecamines. Despite predictions of Gecamines operations coming to a grinding halt owing to its multitude of problems, the company continued to operate, albeit at limited capacity. Changing Government policies promoting privatization of the state-run mining sector to attract new foreign capital and technical expertise holds some hope for the future. Because of its size and wealth of resources Zaire's long-term potential was more promising, and the country could remain an important supplier of copper, cobalt, and diamond for years. Much of Zaire's future mineral output will hinge on the availability of financing. Zaire's prospects depend on its ability to achieve political and economic stability, mobilize its resources, control Government spending, and attract new foreign investment.

## References Cited

Africa Energy & Mining, 1996, Zaire—Barrick-Okimo in firm deal: Africa Energy & Mining (Paris), August 28, no.187, p. 6.

American Mineral Fields, 1996, American Mineral Fields Inc. prospectus on Canadian stock offering of August 22, p. 1-26.

Anvil Mining, 1997, Report for quarter ending December 31, 1996: Anvil Mining NL, January 29, 1997, 2 p. (Accessed April 3, 1997, on the World Wide Web at URL http://erd.pair.com/Anvil_Mining/)

Banro Resource Corp, 1996, Banro completes purchase of SOMINKI S.A.R.L.

(Zaire): Banro Resource Corp. press release, January 31, 1996, 2 p. (Accessed March 18, 1998, on the World Wide Web at URL http://www.banro.com/releases/)

———1997, Banro Resource to begin major exploration program: Banro Resource Corp. press release, January 31, 1996, 2 p. (Accessed March 18, 1998, on the World Wide Web at URL http://www.banro.com/releases/)

Consolidated Eurocan Ventures, 1996a, Consolidated Eurocan Ventures reports on Tenke Fungurume: Consolidated Eurocan Ventures press release, August 15, 1996, 3 p. (Transmitted by Canadian Corporate News on the World Wide Web at URL http://www.cdn-news.com/)

———1996b, Consolidated Eurocan Ventures reports on current status of discussions with Gecamines and the Government of the Republic of Zaire. Consolidated Eurocan Ventures press release, November 20, 1996, 1 p. (Transmitted by Canadian Corporate News on the World Wide Web at URL http://www.cdn-news.com/)

Financial Times, 1996, Voisey's Bay man aims to repeat success with Zairian zinc project: Financial Times [London], September 26, p. 22.

International Panorama Resources, 1996a, Acquisition of copper-cobalt tailings project in Zaire: International Panorama Resources press release, August 6, 2 p.

———1996b, Zaire Government Ratifies Agreement with International Panorama Resources. Press Release, September 16, 1996, 2 p.

———1996c, Int'l Panorama poised to net $900 million from cobalt project: International Panorama Resources press release, November 7, 2 p.

International Petroleum Encyclopedia, 1997. International Petroleum Encyclopedia—1996: PennWell Publishing Co., Tulsa, p. 306.

Journal of Commerce, 1994, Zairian aide calls ship looting "Perilous." Journal of Commerce, Washington, DC, v. 400, no. 28, 205, April 15, p. 12B.

Metal Bulletin, 1996a, Lundin wins Tenke Fungurume tender in Zaire. Metal Bulletin, no. 8106, August 22, p. 9

———1996b, AMF and Anglo continue Kipushi talks. Metal Bulletin, no. 8106, October 28, p. 15.

———1997, Tenke Fungurume to become Voisey's Bay of copper. Metal Bulletin, no. 8132, February 20, p. 9.

Mining Journal, 1996, Diamond smuggling: Mining Journal, August 2, v. 327, no. 8389, chart, p. 94.

Mulenga, Mildred, 1997, Diamond smuggling increases in Zaire: Panafrican News Agency, March 18, 1 p.

Randol International, 1996, Tenke Fungurume: Randol International Mining Opportunity Bulletin, Fall 1996, v. 3, no. 3, p. 1, 15.

World Diamond Industry Directory & Yearbook, 1997/1998, World Mining Review in World Diamond Industry Directory & Yearbook, 1997/1998: [London], CRU Publishing Ltd., 1997, p. 21.

Yenga, M., 1996, Zaire in Mining Annual Review 1996: Mining Journal, [London], July, p. 151.

## Major Sources of Information

Ministere des Mines
3eme Niveau, Building Gecamines
Boulevard du 30 Juin
Kinshasa/Gombe,
Republique Democratique du Congo
Telecel: (243)-(12)-42-816, 42-817, or 42-818
Telephone: (243)-(12)-21-238

## TABLE 1
## ZAIRE: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

| Commodity | | 1992 | 1993 | 1994 | 1995 | 1,996 |
|---|---|---|---|---|---|---|
| METALS | | | | | | |
| Cadmium, smelter | | 84 | 12 | -- | -- | -- |
| Cobalt: | | | | | | |
| Mine output, Co content | | 5,700 | 2,459 | 826 | 1,674 | 2,000 e/ |
| Metal, Co content: | | | | | | |
| Refinery (salable products) | | 5,049 | 831 | 2,329 | 3,441 | 4,200 e/ |
| White alloy, matte | | 1,580 | 1,267 | 945 | 546 | 546 e/ |
| Columbium and tantalum: | | | | | | |
| Columbite-tantalite concentrate: | | | | | | |
| Gross weight | kilograms | 29,000 | 20,000 e/ | 4,120 | -- | -- |
| Cb content e/ | do. | 7,500 | 5,000 | 1,000 | -- | -- |
| Ta content e/ | do. | 8,000 | 5,700 | 1,000 | -- | -- |
| Pyrochlore concentrate: e/ | | | | | | |
| Gross weight | do. | 780,000 | 780,000 | -- | -- | -- |
| Cb content | do. | 350,000 | 350,000 | -- | -- | -- |
| Copper: 2/ | | | | | | |
| Mine output: | | | | | | |
| By concentration or cementation | | 25,100 | 6,900 | 7,200 | 6,800 | 6,200 |
| Leaching (electrowon) | | 119,400 | 39,400 | 22,800 | 22,600 | 22,600 |
| Total | | 144,500 | 46,300 | 30,000 | 29,400 | 28,800 |
| Metal: | | | | | | |
| Smelter, primary: | | | | | | |
| Electrowon (low grade) | | 110,200 | 37,100 | 22,800 | 22,600 | 22,600 |
| Other | | 23,200 | 5,700 | 7,200 | 6,200 | 6,000 |
| Total | | 133,400 | 42,800 | 30,000 | 28,800 | 28,600 |
| Refinery, primary: | | | | | | |
| Electrowon | | 9,600 | 2,300 | -- | -- | -- |
| Other | | 47,600 | 34,100 | 29,000 | 33,000 | 28,000 |
| Total | | 57,200 | 36,400 | 29,000 | 33,000 | 28,000 |
| Gold e/ | kilograms | 9,000 | 8,700 | 11,100 | 10,000 | 8,200 |
| Silver e/ | do. | 29,500 | 11,000 | 900 | 900 | 900 |
| Thorium, monazite concentrate, gross weight e/ (55% rare-earth oxides) | | 50 | 20 | -- | -- | -- |
| Tin: | | | | | | |
| Mine output, Sn content | | 1,020 | 700 e/ | 1,000 | 650 | 500 e/ |
| Smelter, primary e/ | | 50 | 50 | 50 | -- | -- |
| Zinc: | | | | | | -- |
| Mine output, Zn content | | 22,300 | 6,830 | 100 | -- | -- |
| Metal, primary, electrolytic | | 18,800 | 4,150 | -- | -- | -- |
| INDUSTRIAL MINERALS | | | | | | |
| Cement, hydraulic | | 174,000 | 149,000 | 50,000 e/ | 25,000 e/ | 10,000 e/ |
| Diamond: e/ | | | | | | |
| Gem | thousand carats | 8,930 3/ | 2,000 | 3,000 | 4,000 | 3,000 |
| Industrial | do. | 4,570 3/ | 13,600 | 13,300 | 13,000 | 17,600 |
| Total | do. | 13,500 3/ | 15,600 3/ | 16,300 | 17,000 | 20,600 |
| Lime e/ | | 64,600 3/ | 50,000 | 50,000 | 50,000 | 50,000 |
| Stone, crushed e/ | | 280,000 | 200,000 | 200,000 | 200,000 | 200,000 |
| Sulfur: | | | | | | |
| S content of sulfuric acid from sphalerite e/ | | 11,000 | 2,000 | -- | -- | -- |
| Sulfuric acid, gross weight: | | | | | | |
| From sphalerite | | 33,200 | 6,000 e/ | -- | -- | -- |
| From imported sulfur | | 36,300 | 10,000 e/ | 15,000 e/ | -- | -- |
| Total | | 69,400 | 16,000 e/ | 15,000 | -- | -- |
| MINERAL FUELS AND RELATED MATERIALS | | | | | | |
| Coal, bituminous e/ | | 61,000 | 14,000 3/ | 11,000 3/ | 10,000 | 10,000 |
| Petroleum: | | | | | | |
| Crude | thousand 42-gallon barrels | 8,687 | 8,285 | 9,125 | 10,220 | 10,000 e/ |
| Refinery products: | | | | | | |
| Liquefied petroleum gas e/ | do. | 3 3/ | 5 | 5 | 5 | 1 |
| Gasoline | do. | 201 | 365 | 365 | 365 e/ | 89 e/ |
| Kerosene and jet fuel | do. | 199 | 545 | 545 | 545 e/ | 135 e/ |
| Distillate fuel oil | do. | 317 | 365 | 365 | 365 e/ | 90 e/ |
| Residual fuel oil | do. | 193 | 1,095 | 1,095 | 1,095 e/ | 280 e/ |
| Refinery fuel and losses | do. | 56 | 180 | 545 4/ | 545 e/ 4/ | 135 e/ 4/ |
| Total | do. | 969 | 2,000 | 2,920 | 2,920 e/ | 730 e/ |

e/ Estimated. r/ Revised.

1/ Table includes data available through June 21, 1997.

2/ Terms are used as defined by the International Copper Study Group.

3/ Reported figure.

4/ Includes "other."

## THE MINERAL INDUSTRY OF

# ZAMBIA

### By Thomas P. Dolley and George J. Coakley

Zambia is a landlocked, southern African country with an area of 753,000 square kilometers (km$^2$), nine million people and a per capita gross domestic product (GDP) of $450.[1] Copper and cobalt production by the state-owned, Zambian Consolidated Copper Mines Ltd. (ZCCM) continued to be the major component of the minerals sector of the Zambian economy and its chief source of foreign exchange earnings in 1996. Zambia ranked as the world's 2d largest producer of cobalt, after Canada; 11th largest producer of copper, after Mexico; and as one of the top producers of gem-quality emeralds in 1996. Trade statistics by the International Monetary Fund indicated the estimated value of Zambian exports at $982 million for 1996 (International Monetary Fund, 1997). Copper accounted for about 80% of export earnings in 1996. Gemstones, mostly emeralds, also recorded significant earnings, but probably an even larger amount bypassed official channels. (*See table 1.*) Resources of those minerals in production generally were extensive, including separate, unexploited deposits in various areas, and occurrences of other potentially valuable minerals were widespread geographically in this Texas-sized country.

The major import by far was petroleum, including crude and refined products principally from the Arabian Gulf States. Fertilizer components were the second largest mineral import, particularly phosphorus and potassium. South Africa was a principal source of imports, at least partly because of transshipments from overseas sources. Mining equipment was normally the largest import from the United States.

Zambia's economy was dependent on one commodity, copper; however, the Government's past practice of diverting mineral earnings for various social or other economic purposes, while neglecting the need for reinvestment in the industry, has led to a progressive decline in copper production and revenue. As part of the economic reform program and transition to a market economy, the Government began in 1994 to privatize most of the country's more than 100 companies. In late 1996, the Government proceeded with plans to privatize ZCCM, the country's major single enterprise. ZCCM had been formed in 1982 with the merger of Nchanga Consolidated Copper Mines Ltd. and Roan Consolidated Copper Mines Ltd., making it at the time the world's second largest copper company after Codelco-Chile.

During the year, ZCCM issued a document, Invitation to Prequalify, for the sale of majority interests in certain mining andelectricity distribution assets of the company by international tender. The assets for sale were partitioned into packages as follows:

Package A—Nchanga Division and Nkana Division (excluding the Kansanshi and Chambishi Mines, the Chingola refractory ore dumps and the Chambishi cobalt plant) and their respective social assets. This package includes five underground mines and one open pit mine, associated concentrator facilities, a tailings leach plant, a copper smelter and refinery, an acid plant, and a cobalt plant. In the financial year 1995-96, approximately 11.1 million metric tons (Mt) of ore was mined and 175,000 metric tons (t) of copper cathode was produced at Nchanga/Nkana as well as 1,939 t of finished cobalt.

Package B—Luanshya Division (excluding the Ndola precious metals plant) and its associated social assets. Luanshya Division includes the underground mines at Luanshya and Baluba, associated concentrator facilities, the (currently nonoperational) Luanshya smelter and Ndola Copper Refinery. In 1995-96 approximately 2.9 Mt of ore was mined and 47,000 t of copper and 1,015 t of cobalt in concentrates were produced at the Luanshya Divison.

Package C—The Mufulira underground mine and concentrator which in 1995/96 produced approximately 52,000 t of copper in concentrate.

Package D—The Chambishi copper mine (currently nonoperational) which has proven reserves of 33.5 Mt at 2.55% copper to the 900 meter (m) level, an existing production shaft to that level and additional resources estimated to exceed 100 Mt.

Package E—The Kansanshi copper mine (currently being operated on a small scale only) which has a resource, based on limited drilling, of 24.4 Mt at 2.90% copper (with a 1.5% cut-off).

Package F—The Nampundwe pyrite mine, which in 1995-96 fiscal year ending March 31, 1996, produced approximately 240,000 t of ore.

Package G—The Chambishi cobalt plant, which has a nominal capacity of 2,400 tons per year (t/yr) and produced 1,638 t of finished cobalt in 1995-96, and its associated acid plant.

Package H—The Ndola precious metals plant produces gold, silver, and selenium from copper refinery slimes.

Package J—Power Division (excluding the bulk transport fleet) that currently purchases electricity from the state-owned Zambia Electricity Supply Co. and sells it to ZCCM's mining operations and other customers. In 1995-96 ZCCM's own power consumption was approximately 5,000 gigawatt-hours with a peak demand of 500 megawatt (MW). The Power Division distributed two-thirds of Zambia's electricity.

---

[1] Where necessary, values have been converted from Zambian Kwacha (K) to U.S. dollars at the rate of K1245=US$1.00 for 1996.

[2] Ministry of Mines and Minerals Development. Zambia's Mining Policy, Lusaka, Dec. 1995, 13p.

The ZCCM Invitation to Pre-qualify instructed parties interested in prequalification to make submissions by September 27, 1996. Additionally, the document indicated that parties may bid for and acquire interests in one or more of Packages A through H; however, parties which acquire an interest in Package J may not acquire an interest in any of the other packages. Bids for the packages were to be submitted to the Zambia Privatisation Agency (ZPA) by February 28, 1997, except for Package E, due to ZPA by November 29, 1996 (Zambian Consolidated Copper Mines Ltd., 1996b). Subsequently, a total of 38 companies prequalified for the sale, including Australia's Western Mining Corp.; Canada-based Falconbridge, Indochina Goldfields, Noranda, and Teck; China's China National Non-ferrous Metals Corp.; the South African-based companies Gencor, Anglovaal, and Iscor; and Phelps Dodge and Cyprus Amax Minerals Co. of the United States (Metal Bulletin, 1996).

The Investment Act of 1993 established the Zambia Investment Center as a one-stop support facility for investors and offers incentives to investors in the mining sector. In December 1994, the Government announced its policy to no longer participate in exploration or become a shareholder in a mining company and to limit its functions to regulatory or promotional activities. Subsequently, the new December 1995 Mining Policy officially put in place a privatization program to encourage private development and diversification of the mining sector to promote small-scale mining; to promote development of gemstone mining and liberalization of gemstone marketing facilities; to promote exploitation of industrial and energy minerals and development of ferrous minerals; to promote reduction of ecological damage arising from mining; and to promote local value added processing of Zambia's mineral raw materials.[2]

The Government continued to promote actively the private sector and seek foreign investment, particularly in minerals. The Mines and Minerals Act of 1995, passed by Parliament as 1995 Act No. 31 on September 13, 1995, was aimed at attracting risk capital, technology, and entrepreneurial efforts to the mining sector. The law covers all mineral commodities and treats large-scale, small-scale, and gemstone operations separately as to mineral rights (prospecting and mining authorizations). Export of radioactive minerals, such as monazite, is illegal without special Ministerial approval. It also gives the Government leeway in negotiating individualized contracts with investors. Among other provisions reported were secure title to mining rights with provision to assign; right to market products; international arbitration; and exemption from import duties and sales taxes on material, at least for an initial period of exploration and development. Additionally, the law provides for royalty charges of 3% for large-scale mining license holders on the "net back value" of minerals free-on-board, less transport, and smelting and refining costs.

Parliament's Environmental Protection and Pollution Control Act (No. 12) of 1990 (EPPCA) formed the basis for a Ministry of Environment and Natural Resources and also an Environmental Council of Zambia. The act formally came into full force in February 1992 and gave the Ministry overall responsibility for protecting the environment.

ZCCM had followed a self-regulatory approach to environmental protection for sometime. It established standards based on limits elsewhere in the world. After the EPPCA came into full force, ZCCM put into place an appropriate management structure with the help of consultants under a World Bank Technical Assistance package. In April 1994, ZCCM commenced a more intensive 2-year program of personnel education, discharge measuring, formal reporting, mass balance studies, monitoring stations installation, and conceptual rehabilitation planning. During 1996, the Government issued new Mines and Minerals Environmental Regulations to implement environmental protection provisions of the Mines and Minerals Act of 1995.

In 1996, ZCCM copper mine production of 334,000 t continued its decline, dropping to 55% of 1985 levels and 40% of the 1969 peak production of 825,000 t. It should be noted that for purposes of reporting statistical and other technical data on ZCCM for 1996 in this chapter information from ZCCM for the quarter ending March 31, 1997, which covers the fiscal year April 1, 1996, to March 31, 1997, has been used (Zambia Consolidated Copper Mines Ltd., 1997). The copper and cobalt resource base still needed substantial new capital investment to expand production, particularly from deeper ore bodies. Cobalt estimated mine production decreased to 63% and refined cobalt to 46% of 1995 levels, both still low by historical standards. Zambia is a major world supplier of emerald and amethyst and additionally produces gemstone quality aquamarine, tourmaline, and garnet. Most gemstone mining is done by small-scale, artisanal miners and production and export levels are poorly documented. Cement production increased over 1995 levels. Petroleum refinery products output probably were lower, based on reports of operating difficulties, but numerical information was not available for estimating any decline.

The major mineral exports by value were copper and cobalt. However, some observers believed gemstones were very significant in export value for some time, possibly second to copper, despite the absence of official records. The value of legally and illegally exported gemstones may be as much as $250 million annually. Based on $1.11 billion in ZCCM sales of copper and cobalt sales in the fiscal year ending March 31, 1997, 27.9% of shipments went to Japan, 19.3% to the European Community, 10.8% to India, 6.8% to Thailand, and 2.9% to the United States. The difference between export and sales values is accounted for by domestic sales and by metals bought by ZCCM to meet customer contracts.

The Government still dominated the industry, although the tempo of efforts at privatization appeared to be increasing. The state-owned Zambia Industrial and Mining Corp. Ltd. (ZIMCO), scheduled for phaseout in 1994, but apparently still functioning early in 1996, held a majority interest in all principal commercial and industrial ventures other than those privatized. ZCCM, the largest entity in the minerals sector, was owned 60.3% by ZIMCO, 27.3% by Zambia Copper Investments Ltd. (owned 50% by Minorco S.A., in turn, owned more than 60% by the Anglo American Corp.-DeBeers Centenary AG Group), and 12.4% by the public, including institutions. A small mines development unit of ZCCM supported at least one mine for gemstones in the Eastern Province and one gold and one copper mine in the Western Province. Other units also produced lime and marble, and ZCCM also owned shares in several ventures not related to minerals.

Anglo American Corp. of South Africa Ltd. (AAC) began negotiations with the Government to acquire rights to develop the Konkola Deep Mining Project, which contains a known resource reported by ZCCM in the Kirila Bombwe part of the ore body at 297 Mt grading 3.8% copper and 0.07% cobalt. The Konkola Deep development is considered a key to maintaining or expanding future copper production in Zambia.

ZCCM reported resources as of March 31, 1996, at Chambishi of 136 Mt grading 2.4% copper. By January 1997, the Government announced it had signed a sale agreement and associated documentation with Cyprus Amax Minerals Company of the United States providing the company with an 80% interest in the Kansanshi copper mine and deposit. The Kansanshi deposit contains an estimated resource of 24.4 Mt at 2.9% copper. A 20% interest in the deposit will be maintained by ZCCM. In order for Cypus to maintain its interest Kansanshi, the company must proceed with a 3-stage exploration and development project costing about $48 million. In the event that Cyprus does not proceed beyond stages one or two, the property ownership will revert to ZCCM and Cyprus Amax must pay ZCCM 5% of any shortfall in committed expenditures (Zambian Consolidated Copper Mines Ltd., 1996a).

Other ZIMCO subsidiaries in the minerals sector included wholly owned Reserved Minerals Corp., which, in turn, owned 100% of Mindeco Small Mines Ltd. (producer of several industrial minerals) and 55% of Kagem Mining Ltd. (reportedly the country's largest gemstone producer, 45% of which was owned by the Hagura organization, a private partnership); Chilanga Cement Co., 60% or more owned through Indeco Ltd., another wholly owned subsidiary of ZIMCO, with an unspecified share owned by Commonwealth Development Corp. of the United Kingdom (the Zambia Government's 60% was formally tendered for sale in late 1994); wholly owned Nitrogen Chemicals of Zambia Ltd., producer of ammonia and compounder of fertilizers and explosives; wholly owned Maamba Collieries Ltd., the country's sole coal producer; and Indeni Petroleum Refinery Co. Ltd., 50% owned through Indeco Ltd. with at least some portion believed owned by Agip SpA. of Italy, the operating manager.

Additionally, among more than 100 companies, ZIMCO also had majority or full ownership of some minerals-related businesses, such as crushed stone, glass, and ceramics firms; Metal Marketing Corp. of Zambia, a minerals and metals trading firm; as well as Tazama Pipelines Ltd. (the crude oil pipeline from Dar es Salaam), Zambia Railways Ltd., domestic and international airlines, and electric utilities. Private entities operated a number of small mines for which little information was available. More than 20 such mines produced gemstones. Others produced limited quantities of gold, apparently mostly alluvial, as well as tin and a variety of industrial minerals.

Significant exploration was being conducted throughout the country. More than 70 separate licenses were in effect covering large areas, especially the northwest, southeast, and much of the areas surrounding ZCCM's mine sites. In addition to copper-cobalt and lead-zinc ores, the companies targeted gold and nickel minerals, diamonds and other gemstones, fluorspar, and phosphate. Several international mining groups were involved, such as BHP and Western Mining Corp. Ltd. from Australia; SouthernEra Resources Ltd. from Canada; AAC, Gencor, Johannesburg Consolidated Investment Co. Ltd. (JCI), and Trans Hex Group Ltd. of South Africa; RTZ; Phelps Dodge; and a number of smaller ventures.

Additionally, recovery of cobalt, copper, lead, and zinc from tailings and slag dumps on ZCCM and other properties were of interest to several companies. Colossal Resources Corp. of Vancouver, Canada, which acquired a 60% interest in the slag processing venture of the Zambian firm, Qasim Mining Enterprises Ltd. in 1994 commenced with the reprocessing of 8.6 Mt of cobalt slag grading 0.70% to 0.81% cobalt and 1.15% copper from ZCCM's Nkana Slag Dump. In August 1996, Colossal initiated processing of the slag and began sales of the recovered cobalt by yearend. The company's expectations are to process 4,000 to 6,000 t of slag per month during the first year of operation, resulting in 50 t of recovered cobalt per month (Colossal Resources Corp., 1996).

First Quantum Minerals Ltd. of Vancouver, Canada, announced the formal acquisition of a 100% interest in the Bwana M'kubwa Copper Project (BMCP) on June 21, 1996. The company also reported that construction work had also begun on the BMCP. The BMCP is based on a renewable 10-year mining license covering about 5,800 hectares near Ndola in the Zambian Copperbelt. The BMCP mining license is the first such license to be issued by the Government since enacting the new Mines and Minerals Act of 1995. The first stage of the project comprises the building of a leach, solvent extraction, electrowinning (SX-EW) treatment plant to recover and treat copper from the No. 4 Tailings Dam at Bwana M'kubwa. The plant will take 14 months to build at a capital cost of $32 million and will produce 9,720 t cathode copper, 234 t of rough copper, and 60,000 t of sulfuric acid for sale yearly (First Quantum Minerals Ltd., 1996).

Caledonia Mining Corp. of Toronto, Canada, acquired two additional exploration licenses, Ngosa and Luamafula, adjacent to its Nama license. The Nama area covers 93 km$^2$ and is located about 10 kilometers (km) west of ZCCM's Konkola copper property in the Copperbelt. Exploration during 1995 and 1996 identified 14 cobalt geochemical anomalies. In the Nama area, results of the drilling produced an estimate of indicated and inferred reserves of 849 t at 0.029% cobalt equivalent. Additionally, Caledonia's exploration at the Kadola West copper oxide deposit have indicated an inferred mineral resource of 74 Mt grading 0.95% total copper equivalent. The Kadola deposit is approximately 40 km south of the Luanshya Mine on the southern end of the Zambian Copperbelt (Caledonia Mining Corp., 1996).

In Zambia, ZCCM operates one of the largest copper mining complexes in the world through five divisions, Nchanga, Mufulira, Nkana, Luanshya, and Konkola. The Nchanga Division operates one underground and one cobalt-rich open pit copper mine, the Nchanga mill, and a tailings leach plant. As reported by ZCCM, Nchanga produced 157,623 t of copper contained in ore and reclaimed tailings in 1996. Total production of cobalt at ZCCM's operations was 5,126 t for 1996 (Zambian Consolidated Copper Mines Ltd., 1997).

The Mufulira Division operates one major underground mine, a mill, smelter, and refinery. In 1996 Mufulira produced 65,775 t of copper contained in ore and reclaimed tailings.

The Nkana Division mines ore from four underground zones, Mindola, Central Shaft, South Ore Body, and Chibiluma and operates a mill, smelter, refinery, two cobalt recovery plants and two sulfuric acid plants at Nkana and Chambishi. In 1996, the Nkana Division produced 53,895 t of copper contained in ore and reclaimed tailings.

The Luanshya Division operates the Luanshya and cobalt-rich Baluba underground mines, two mills, and the Ndola precious metals refinery. In 1996, the Luanshya Division produced 51,584 t of copper contained in ore and reclaimed tailings.

The Konkola Division operates a mill and the Konkola underground mine. Konkola, one of the wettest mines in the world, pumps out 275,000 cubic meters a day of water and is becoming a major input to the local water supply. In 1996, Konkola produced 56,256 t of copper contained in ore and reclaimed tailings.

In March 1996, Reunion Mining of the United Kingdom acquired the Dunrobin gold project from JCI. Dunrobin was last mined in the 1930's and Reunion Mining was to commence open pit mining, crushing, agglomeration, and heap leaching by mid-1997. Reunion Mining has a target production rate of 567 kilograms of gold per year. Gold reserves were sufficient for 3 years of production, pending the discovery of reserves which would further extend the life of the mine. There were indications that the gold potential of the property was below the JCI corporate threshold for development (Reunion Mining Plc., 1996).

The Ministry of Mines and Mineral Development continued a program to further develop production of gemstones other than diamonds found in many parts of the country. Training and other assistance were being provided to small local mine operators. The Ministry believed the sector should also be attractive to foreign investment in mining, processing, and marketing. Emeralds, mostly produced about 200 km north of Lusaka (Ndola rural area), were estimated to normally comprise about 80% of total gemstone production in value. In volume, however, amethyst output, mostly from a location about 300 km south-southwest of Lusaka (Kalomo area), usually was the largest reported. Additionally, there was production of aquamarine and tourmaline, mostly from a location about 600 km northeast of Lusaka (Lundazi area), as well as garnet, agate, and other gemstones at a number of locations. Of the 30 to 40 registered gemstone operations reported, two were larger-size, mechanized mines that were joint ventures with the Government. From 200 to several thousand small, unregistered mining operations were estimated to be operational.

Cobalt reserves associated with copper ore at three of ZCCM's mines totaled 123 Mt averaging 0.15% cobalt and 2.33% copper. This did not include reserves at Nchanga totaling 8 Mt at 0.62% cobalt.

Gold ore resources were being studied by several groups but were yet to be fully defined. Many occurrences were located throughout the country, some around and to the east of Lusaka.

Nickel resources at the Munali sulfide deposit were put at 10.4 Mt at 1.1% nickel with minor copper, gold, silver, and platinum-group-metal content. The Kalumbila deposit had resources estimated at 8 Mt at 0.55% nickel. Neither deposit was fully defined and extensions were to be explored. Additional resources are projected at other sites.

A large variety of other metallic minerals deposits, including iron, molybdenum, and tin-tantulum also were known, but needed further exploration.

Of the many industrial mineral resources that were being exploited or studied by commercial groups, gemstones were of the most value, but others included clays for brick and tile, refractories; fluorspar; gypsum; limestone for cement and lime manufacture; magnetite for special purposes; marble; phyllite, probably for cement manufacture; silica, mostly for glassmaking; and talc. Phosphate resources were known, but only of low grade, one of which was a carbonatite deposit in the northeast, the subject of continuing studies by Government agencies.

Coal reserves of 78.2 Mt remained at Maamba, 60.2 Mt in the proven category and 18 Mt in the probable category. Petroleum resources remained conjectural with no known activity after some surveys in 1990 along the Zambesi River east from Victoria Falls to Mozambique.

A reasonably adequate truck road and railway network existed within the country and externally for access to ocean and lake ports for international trade. Major highways generally paralleled the rail lines. About 20% of the main roads were paved and about 20% were gravel or stabilized earth. In 1993, the World Bank's affiliated IDA considered the road system to be essential to economic growth but neglected for years, and gave an $8.5 million credit to restructure the Government system and begin planning for rehabilitation. In early 1995, this resulted in $800 million in pledges for rehabilitation from the World Bank and other donors.

The principal rail routes were northeast to and from the port of Dar es Salaam, Tanzania—nearly 2,000 km from Ndola in the Copperbelt—mostly on the Tanzania Zambia Railways Authority (Tazara) line; and south through Zimbabwe to and from South African ports—more than 2,500 km from Ndola—using the Zambia Railways Ltd. line in Zambia. The roughly 2,000-km rail link southeast to the port of Beira, Mozambique, through Zimbabwe, became generally available after a long hiatus due to civil war in the port country; but ocean ship availability at Beira was apparently limited. The more than 2,200-km rail link north into Zaire and west to the port of Benguela (Lobito), Angola, remained unavailable during the 17-year civil war in Angola; however, the end of the conflict appeared in-sight and the route may become available again in the next few years. The rail system, in general, still had some rolling stock shortages, and track maintenance on internal routes was of concern, but equipment rentals and donor aid programs helped to improve the situation.

A crude oil pipeline ran from Dar es Salaam about 1,700 km southeast to a refinery in Ndola. It was owned and operated by Tazama Pipelines Ltd., a joint venture of the Zambian and Tanzanian Governments.

Electric power capacity was adequate, furnished about 70% from hydroelectric, 20% from oil, and 10% from coal plants. Expansion of hydro sources was planned despite the effect of periodic droughts. Coal was available from domestic deposits. The energy source for mobile equipment continued to be imported petroleum, mostly refined products, although a significant amount imported was crude that was refined in the state-owned facility at Ndola. The household energy source was wood, which continued to be the country's largest single source of energy.

Zambia's ability to turn around its economic difficulties appeared to be tied to the future success of its proposed privatization plan. The economy should benefit from the likely infusion of new foreign investment and technology. In addition, much promise of success can be found in the availability of good agricultural, mineral, and water resources; and a market-oriented Government. With continued political stability and passage of the improved mining and mining investment legislation, the international mining community could be expected to act more vigorously on the opportunities. A number of minerals appeared ready for development. Copper-cobalt output in the short term was likely to decline owing to restructuring and operating problems, however, when the ZCCM privatisation is complete, a reinjection of new capital and technology is expected to restore production to more historical levels. The gemstone sector also has the potential to generate a larger value added industry in Zambia.

## References Cited

Caledonia Mining Corp., 1996, Caledonia announces initial tonnage and grade for its Kadola West Copper Oxide Deposit in Zambia: Caledonia Mining Corp. press release, December 6. (Accessed March 16, 1998, on the World Wide Web at URL http://www.caledoniamining.com)

Colossal Resources Corp., 1996, Colossal announces initial melting of cobalt/copper slag at the Kabwe Plant (KMPP) in Zambia: Colossal Resources Corp. press release, September 4. (Accessed March 19, 1998, on the World Wide Web at URL http://www.colossal-cobalt.com/09_04_96.html)

First Quantum Minerals Ltd., 1996, Completed the formal acquisition of a 100% interest in the Bwana M'kubwa Copper Project: First Quantum Minerals Ltd. press release, December 4. (Accessed March 19, 1998, on the World Wide Web at URL http://www.first-quantum.com/news_96/120496.html)

International Monetary Fund, 1997, Total world exports, by Eastern and Southern African countries: International Monetary Fund, August 6. (Accessed March 16, 1998, on the World Wide Web at URL http://206.65.85.110/Stats/Trade/regional/worldexp.htm)

Metal Bulletin, 1996, ZCCM receives 38 bids: Metal Bulletin [London], November 11, no. 8128, p. 18.

Reunion Mining Plc., 1996, Annual Report 1996: Reunion Mining Plc. press release. (Accessed on the World Wide Web at URL http://www.dspace.dial.pipex.com/town/place/py31/)

Zambia Consolidated Copper Mines Ltd., 1996a, Chairman's letter to all shareholders of the company: Zambia Consolidated Copper Mines Ltd., 4 p.

———1996b, Invitation to pre-qualify: Zambia Consolidated Copper Mines Ltd., 1 p.

———1997, Report for fourth quarter 1996/97: Zambia Consolidated Copper Mines Ltd., 5 p.

## Major Sources of Information

Zambia Investment Centre
5th Floor, Ndeke House
Haile Selassie Avenue
P.O. Box 34580
Lusaka, Zambia
Telephone: 260-1-252130 or 252133
Fax: 260-1-252150
E-mail: invest@zamnet.zm

Ministry of Mines and Minerals Development
Permanent Secretary
P.O. Box 31969
Lusaka, Zambia
Telephone: 260-1-254107
Fax: 260-1-251224

Director, Mines Development Department
P.O. Box 31969
Lusaka, Zambia
Telephone: 260-1-251719
Fax: 260-1-252916

Director, Geological Survey Department
P.O. Box 50135
Lusaka, Zambia
Telephone: 260-1-251570
Fax: 260-1-251973

## Major Publication

Investment Opportunities in the Mineral Sector of Zambia, Ministry of Mines and Mineral Development, Lusaka, Zambia.

## TABLE 1
## ZAMBIA: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

| Commodity 2/ | | 1992 | 1993 | 1994 | 1995 | 1996 |
|---|---|---|---|---|---|---|
| METALS | | | | | | |
| Beryllium: Beryl | kilograms | 504 | 178 | 857 | 1,000 e/ | 1,000 e/ |
| Cobalt: 3/ | | | | | | |
| Mine output, Co content | | 6,910 | 4,840 | 3,600 | 5,908 | 7,900 e/ |
| Metal, Co content | | 4,610 | 4,211 | 2,482 | 3,577 | 5,126 |
| Copper: 3/ 4/ | | | | | | |
| Mine output, Cu content: | | | | | | |
| By concentration or cementation | | 349,100 | 344,200 | 289,800 | 268,900 | 278,800 |
| Leaching (electrowon) | | 80,400 | 84,100 | 83,400 | 54,800 | 55,000 |
| Total | | 429,500 | 428,200 | 373,200 | 323,600 | 333,700 |
| Metal: | | | | | | |
| Smelter, primary: | | | | | | |
| Electrowon (low grade) | | 63,900 | 62,400 | 25,342 | 22,455 | 25,000 e/ |
| Other | | 356,400 | 305,100 | 241,036 | 234,457 | 250,300 |
| Total | | 420,300 | 367,600 | 266,378 | 256,912 | 275,300 |
| Refinery, primary: | | | | | | |
| Electrowon | | 43,700 | 48,800 | 67,255 | 45,713 | 54,600 |
| Other | | 428,500 | 363,200 | 284,784 | 275,572 | 270,300 |
| Total | | 472,200 | 412,100 | 352,039 | 321,285 | 324,900 |
| Gold 3/ | kilograms | 271 | 235 | 123 r/ | 91 | 100 e/ |
| Lead: 3/ | | | | | | |
| Mine output, Pb content | | 4,446 | 7,027 | -- | -- | -- |
| Metal, refined | | 3,030 | 2,000 | -- | -- | -- |
| Manganese concentrate (e/ 48% Mn), gross weight | | 292 | -- | -- | -- | -- |
| Selenium, refined, gross weight 3/ | kilograms | 31,800 | 26,700 | 21,115 | 18,550 e/ | 20,000 e/ |
| Silver 3/ | do. | 21,000 | 18,000 | 10,002 | 8,676 | 9,700 e/ |
| Tin concentrate: | | | | | | |
| Gross weight (65% to 72% Sn) | | 3 | -- | -- | -- | -- |
| Sn content | | 2 | -- | -- | -- | -- |
| Zinc: 3/ | | | | | | |
| Mine output, Zn content of ore milled | | 14,706 | 16,704 | -- | -- | -- |
| Metal, refined | | 7,290 | 3,450 | -- | -- | -- |
| INDUSTRIAL MINERALS | | | | | | |
| Cement, hydraulic e/ | | 347,000 | 310,000 | 280,000 5/ | 250,000 | 350,000 |
| Clays: | | | | | | |
| Brick e/ | | 3,000 | 3,000 | 3,000 | 3,000 | 3,000 |
| Building, not further specified e/ | | 2,000 | 2,000 | 27,000 5/ | 30,000 | 30,000 |
| China and ball e/ | | 200 | 200 | 200 | 200 | 200 |
| Feldspar | | 113 | 100 e/ | -- | -- | -- |
| Gemstones: | | | | | | |
| Amethyst | kilograms | 479,000 | 398,000 | 366,000 | 350,000 e/ | 350,000 e/ |
| Aquamarine | do. | 254 | 74 | 21 | 200 e/ | 200 e/ |
| Emerald | do. | 453 | 138 | 160 | 180 e/ | 180 e/ |
| Gypsum e/ | | 13,900 | 14,000 | 11,200 | 11,000 | 11,000 |
| Lime, calcined | thousand tons | 193 | 206 | 195 | 200 e/ | 200 e/ |
| Limestone (cement and lime) e/ | do. | 800 | 770 | 710 | 800 | 800 e/ |
| Magnetite, gross weight | | 417 | 1,250 | 1,070 | 1,000 e/ | 1,000 e/ |
| Nitrogen: N content of ammonia e/ | | 7,000 | 5,000 | 3,000 | 3,000 | 3,000 |
| Sand and gravel, construction e/ | thousand tons | 500 | 500 | 117 5/ | 200 | 200 |
| Stone, construction: | | | | | | |
| Limestone, crushed aggregate e/ | do. | 680 | 632 5/ | 668 5/ | 700 | 700 |
| Other e/ | do. | 700 | 700 | 700 | 700 | 700 |
| Sulfur: 3/ | | | | | | |
| Pyrite concentrate: | | | | | | |
| Gross weight (e/ 42% S) | | 78,200 | 80,800 | 55,572 | 69,228 | 70,000 e/ |
| S content e/ | | 32,400 | 33,400 | 22,062 5/ | 28,314 5/ | 26,000 |
| In sulfuric acid from: e/ | | | | | | |
| Pyrite roaster gas, S content | | 29,000 | 30,000 | 19,900 | 25,500 | 20,000 |
| Metallurgical gas, S content | | 70,000 | 56,000 | 40,700 5/ | 71,150 5/ | 60,000 |
| Total, S content | | 99,000 | 86,000 | 60,600 5/ | 96,650 5/ | 80,000 |
| Talc | | 366 | 62 | 76 | 80 e/ | 80 |

See footnotes at end of table.

## TABLE 1--Continued
## ZAMBIA: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

| Commodity 2/ | | 1992 | 1993 | 1994 | 1995 | 1996 |
|---|---|---|---|---|---|---|
| MINERAL FUELS AND RELATED MATERIALS | | | | | | |
| Coal, bituminous | thousand tons | 422 | 301 | 163 | 141 e/ | 100 e/ |
| Petroleum, refinery products: e/ 3/ | thousand 42-gallon barrels | 5,300 | 5,300 | 5,300 | 5,000 e/ | 5,000 e/ |

e/ Estimated.

1/ Table includes data available through June 15, 1997.

2/ In addition to commodities listed, the following were probably produced but information is inadequate to reliably estimate output: fluorspar, tourmaline, additional crude construction materials at artisanal operations (clays for brick and tile; sand, gravel, and stone for aggregate and fill; dimension stone; et al), and clay and/or shale normally used for cement manufacture. Some "industrial sand" and minor amounts of "phyllite" and "silicate" production also was reported but not further defined.

3/ Data are for year beginning Apr. 1 of year stated.

4/ Terms are used as defined by the International Copper Study Group.

5/ Reported figure.

## THE MINERAL INDUSTRY OF

# ZIMBABWE

### By Philip M. Mobbs

The mineral industry of Zimbabwe was a major contributor to the world supply of chrysotile asbestos, ferrochromium, and lithium minerals. The nation's mineral industry was diverse, with a nucleus of asbestos, coal, chromite, copper, diamond, gold, granite, and nickel operations. It accounted for about 8% of the nation's gross domestic product. Gold production was the country's leading mineral sector in 1996 with output exceeding 24 metric tons and a value of $280 million. Intense diamond exploration activity continued throughout the country during the year.

All mining activities came under the Mines and Minerals Act (Chapter 165) (1961), its amendments, and associated regulations. All mineral rights were vested in the state through the President of Zimbabwe. Security of tenure was assured by the law. Corporate tax levels were 37.5%, and the individual rate was 40%. Buildings, equipment, shaft sinking, and premining development could be expensed at 100% in the year of the expenditure.

The Zimbabwe Investment Center assisted investors with permits and licenses and sanctioned investment projects. The Gold Trade Act gave the Reserve Bank of Zimbabwe the monopoly on purchasing and exporting all gold produced in Zimbabwe. In October, the Reserve Bank changed its gold payment policy and began paying producers the value of refined gold in U.S. dollars rather than the assayed value of delivered doré in Zimbabwe dollars. The Minerals Marketing Corp. Zimbabwe handled most other mineral exports.

Under the provisions of the Mines and Minerals Act, the Ministry of Mines was responsible for verifying that exploration and development operations have minimal long-term environmental impact. The Ministry of Lands, Agriculture, and Water Development monitored water pollution under the Water Act (1976), as did the Ministry of Environment and Tourism's Department of Natural Resources under the Natural Resources Amendment Act (1975). The Ministry of Health was responsible for air quality under the Atmospheric Pollution Prevention Act (1971).

Most of the country's mineral industries were export-oriented and subject to world market fluctuations. Many minerals were processed prior to export in accordance with the Government's strategy of increasing value-added natural-resource exports. For 1996, mineral exports increased 13% in terms of Zimbabwe dollars (Chamber of Mines Journal, 1997b), in U.S. dollar terms, however, exports were valued at about $707 million,[1] which was down from $731 million in 1995. Mineral commodities exported in 1996 included gold, high-carbon ferrochrome ($138 million), asbestos ($70 million), nickel ($69 million), low-carbon ferrochrome ($48 million), ferrosilicon chrome ($18 million), black granite (dimension stone) ($17 million), copper ($16 million), diamond ($8 million), coke ($8 million), steel ($6 million), graphite ($3 million), platinum-group metals (PGM) ($3 million), lithium minerals ($3 million), emeralds ($2 million), and coal ($2 million). Mineral exports accounted for about 45% of Zimbabwe's foreign currency earnings.

Exclusive prospecting orders (EPO's) were renewable 3-year rights to search for specified minerals in a given geographic location issued by the Ministry of Mines. More than half of the 226 EPO's in effect had been issued for diamond only, Additionally, 43 EPO's were for diamond and gold, and 26 were for gold only. At yearend, about 160 applications for EPO's were being reviewed.

Zimbabwe had a significant local mining industry. More than 500 gold mining operations were registered, many of which were small scale (S.T. Mombeshora, Minister of Mines of Zimbabwe, unpublished data, 1997). Multinationals, such as Anglo American Corporation Zimbabwe Ltd., Falcon Gold Zimbabwe Ltd., Lonrho Zimbabwe Ltd., Rio Tinto Zimbabwe Ltd. (RTZ), and Union Carbide Zimbabwe Ltd., historically have dominated the nation's mining industry. A number of American, Australian, Canadian, European, and South African mining companies were exploring, primarily in the diamond and gold sectors.The Government was pursuing an indigenization policy to increase black Zimbabwean's equity interest in economic multinational mining operations (Indian Ocean Newsletter, 1996).

The state-owned mining company, Zimbabwe Mining Development Corp. (ZMDC), had an interest in a number of mining operations. Refractory ores containing gold were treated at the Government-owned Roasting Plant in Kwekwe. The Government's Industrial Development Corp. of Zimbabwe Ltd. had several subsidiary companies operating in the industrial mineral sector. Mineral exports were usually shipped out of the country aboard the state-owned National Railways of Zimbabwe.

Approximately 45,000 people were employed in medium- and large-scale mining operations, and an estimated 10,000 people worked the nation's smaller mines. Between 100,000 and 300,000 people were estimated to be involved intermittently in informal gold panning. Heavy rains at the beginning of the year adversely affected production for some mineral extration operations. During 1996, 48 fatal mining accidents were reported nationwide compared with 74 during 1995 (Chamber of Mines Journal, 1997a).

---

[1] Where necessary, values have been converted from Zimbabwe dollars to U.S. dollars at the yearend rate of Z$10.9=US$1.00 for 1996 and Z$9.3=US$1.00 for 1995.

Mhangura Copper Mines Ltd. continued to operate despite financial difficulties. Lomagundi Smelting and Mining (Private) Ltd. curtailed mining at the Shackleton copper mine during September. Munyati Mining Co. Ltd., the operations company owned by Reunion Mining PLC of the United Kingdom and ZMDC, mined copper oxide ore at Sanyati. Startup problems in the leach operation resulted in less-than-expected production during the mine's first year of operation (Reunion Mining PLC, 1997). Reunion obtained funding for the CoZiMa Project, the evaluation of cobalt, manganese, and zinc recovery from the Sanyati leachate from the European Investment Bank.

The ferrochrome slag reprocessing plant at the Kwekwe smelter of Zimbabwe Mining and Smelting Co. (Pvt.) Ltd. (Zimasco) came onstream in August. Zimbabwe Alloys Ltd. (Zimalloys) began open-pit mining of chromite at the Airstrip Mine near the Inyala Mine. The 1995 joint venture between low-carbon ferrochrome producer Zimalloys; Japan Metals & Chemicals Co., a Japanese ferroalloy manufacturer; and Mitsui & Co., Ltd., a Japanese trading company, led to the ferrochrome furnace at the Gweru smelter being reengineered and recommissioned in August. After the month-long refurbishment, the ferrochrome furnace proceeded to break plant production records (Zimbabwe Alloys Ltd., 1997).

The largest gold mine in Zimbabwe, the Freda Rebecca Mine, producing at the rate of 2.5-metric-ton-per-year (t/yr) of contained gold, changed hands when Ashanti Goldfields Co. Ltd. of Ghana acquired Cluff Resources Zimbabwe Ltd. The operation included the Rebecca underground mine and the Freda open pit. Ashanti installed a new crushing circuit and planned to expand the treatment plant.

Most of the new gold operations were based on the application of heap-leach technology to old operations or consolidating adjacent, discrete, and small ore bodies into one operation. Although the large mines of Ashanti, Falcon Gold, Lonrho, and RTZ dominated the gold sector, the numerous medium- and small-scale producers contributed about 10% to the nation's gold production. Alluvial gold panning was Zimbabwe's rural alternative to subsistence farming. The Mining (Alluvial Gold) (Public Streams) Regulations (1991) authorized selective alluvial gold mining, but extensive riverbank erosion and stream siltation resulted from significant unauthorized mining activity. The National Miners Association of Zimbabwe (formerly the Small-Scale Miners Association) was attempting to inform the gold panners of potential environmental problems resulting from unauthorized operations.

A number of companies continued gold exploration programs, including Antares Mining and Exploration Corp. of Canada, Ashanti, Forbes and Thompson Ltd. of Zimbabwe, Casmyn Corp. of the United States, International Ballater Resources Inc. of Australia, Oliver Gold Corp. of Canada, Reunion, and Trillion Resources Ltd. of Canada.

Zimbabwe Iron and Steel Co. (Pvt.) Ltd.'s (Zisco) blast furnace No. 4 remained shut down during 1996. Shougang International of China had received the latest contract to refurbish the furnace. Steel production was from the smaller blast furnace No. 3. Zisco had a steel ladle furnace installed and at yearend, the Government proposed to partially divest its interest in Zisco. Steelmakers Ltd. of Kenya proposed to build a rolling mill and a stainless steel plant near Zisco's Redcliff operations.

The continued problems at Zisco's furnace No. 4 resulted in the underutilization of the production capacities of Buchwa Iron Mining Co.'s (BIMCO) new Ripple Creek iron ore mine and at the closing Buchwa iron ore mine. Negotiations began at yearend for BIMCO to supply iron ore to the Beira Iron Project, a proposed hot briquetted iron plant to be erected near the Zimbabwe-Mozambique border.

A Memorandum of Understanding was signed in August allowing the Government to purchase shares in Anglo American Corp. Zimbabwe Ltd. (AMZIM). AMZIM controlled the operations of Bindura Nickel Corp. Ltd.

Zimasco was mining about 240,000 t/yr of PGM ore at its Mimosa Mine near Zvishavane. Platinum-bearing concentrate from the mine was toll smelted in South Africa. BHP Minerals Zimbabwe, a subsidiary of Broken Hill Proprietary Co. Ltd. of Australia (67%) and Delta Gold NL of Australia (33%), stockpiled PGM ore from the $360 million Hartley Mine. Formal commissioning of the mine was postponed until 1997. Unstable ground at the south portal resulted in production stoping beginning at a depth of about 150 meters (m) from the surface instead of the proposed depth of 100 m. The on-site metallurgical plant was designed to process 2.16 million metric tons per year of ore. By November, the mill and the flotation plant were completed.

Additional platinum projects in Zimbabwe being evaluated along the Great Dyke included Delta's 100%-owned Selous platinum prospect, located just south of the Hartley Complex; the Mhondoro Platinum Joint Venture (Delta, 38.7%, and Valley Exploration and Mining Co., a subsidiary of BHP Minerals Zimbabwe, 61.3%), south of Selous; and Delta's Ngezi prospect. Also under exploration were Anglo American's Unki prospect near Shurugwe and the Snakes Head platinum prospect on the northern end of the Great Dyke by the Zimbabwe Geological Survey and the Metal Mining Agency of Japan.

Africa Resources Ltd. of Zimbabwe acquired African Associated Mines from T&N PLC of the United Kingdom. African Associated Mines operated the Shabanie and the Gaths asbestos mines

During 1996, the Wankie Colliery agreed to lease Zisco's coke oven batteries. Wankie also brought its coke oven gas project on-stream. Wankie's coal production remained constrained by lack of local demand. Production was expected to increase in 1997 when the Hwange coal-fired powerplant's expansion was completed. RTZ resuscitated plans to develop Sengwa coal field to supply a proposed mine-mouth powerplant.

United Portland Cement Ltd. installed new limestone crushers and blending beds at its Colleen Bawn works. Sino-Zimbabwean Cement Co., a joint venture of the Industrial Development Corp. of Zimbabwe and the China Building Material Industrial Cooperation of China, began construction of a 250,000-t/yr-capacity cement plant at Indiva, near Gweru.

About 90% of the country was under EPO's for diamond and at various stages of exploration. River Ranch Mine, a joint venture of Redaurum Red Lake Mines Ltd. of Canada and Auridiam Consolidated NL of Australia, was the nation's only active diamond mine. Trillion Resources Ltd. of Canada and Nickelodeon Minerals Inc. of Canada erected a bulk sampling plant on their Sansukwe joint-venture diamond prospect.

Bikita Minerals (Pvt.) Ltd., received certification as an ISO 9002 supplier of lithium minerals. G&W Industrial Minerals (Pvt.) Ltd. acquired the muscovite mines in the Mwami area from Technical Minerals (Pvt.) Ltd.

Most of Zimbabwe's bulk commodities were moved by rail. All major cities and industrial centers were linked to Botswana, Mozambique, South Africa, and Zambia by the National Railways of Zimbabwe's 2,745 kilometers (km) of track. Petroleum products destined for Zimbabwe were piped to Feruka, near Mutare, via the Beira pipeline through Mozambique and then moved west via the Mutare-Harare pipeline or trucked. Zimbabwe had an 85,784-km road network. Zimbabwe was part of the embryonic southern African electrical power pool.

Asbestos, coal, ferroalloys, gold, and nickel were expected to remain the mainstays of the Zimbabwean mineral economy through the turn of the century. The national economic significance of copper, diamonds, granite, and PGM was expected to increase. The continued high cost of domestic capital, potential negative international perception of governmental actions, and any downturn in international metal prices could adversely affect the industry in the short term. Updated investment regulations, the nation's well-developed and well-maintained infrastructure, new exploration techniques, and accessible mineral resources were expected to encourage further local and foreign participation in the mineral industry.

### References Cited

Chamber of Mines Journal, 1997a, Lax supervision major cause of accidents: Chamber of Mines Journal, Harare, v 39, no. 3, pg 109-110.

Chamber of Mines Journal, 1997b, Non-gold mineral exports earn $4,7 bn: Chamber of Mines Journal, Harare, v 39, no.3, pg 11.

Indian Ocean Newsletter, 1996, Zimbabwe-Indigenization agency: Indian Ocean Newsletter, Paris, no. 746, December 21, p. 7.

Reunion Mining PLC, 1997, Annual report—1996: Reunion Mining PLC, 41p.

Zimbabwe Alloys Ltd., 1997, Annual Report—1996: Zimbabwe Alloys Ltd., 28 p.

### Major Sources of Information

Ministry of Mines
Private Bag 7709, Causeway
Harare, Zimbabwe
Telephone: (263) (4) 703-781
Fax: (263) (4) 793-065
Chamber of Mines
4 Central Ave.
P.O. Box 712
Harare, Zimbabwe
Telephone: (263) (4) 707-992
Fax: (263) (4) 707-983
Zimbabwe Geological Survey
Mafue Bldg., 5th and Selous
P.O. Box CY210, Causeway
Harare, Zimbabwe
Telephone: (263) (4) 726-342
Fax: (263) (4) 733-696

### Major Publications

Bartholomew, D.S., Base Metal and Industrial Mineral Deposits of Zimbabwe. Zimbabwe Geological Survey Mineral Resources Series No. 22, Harare, 1990, 154 pp.

———Gold Deposits of Zimbabwe. Zimbabwe Geological Survey Mineral Resources Series No. 23, Harare, 1990, 75 pp.

The Chamber of Mines Journal, Harare, monthly.

Mining in Zimbabwe, Thomson Publications, Harare, annual.

## TABLE 1
## ZIMBABWE: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

| Commodity | | 1992 | 1993 | 1994 | 1995 | 1996 |
|---|---|---|---|---|---|---|
| METALS | | | | | | |
| Antimony, mine output, concentrate, Sb content | | 254 | 95 | 65 | 37 r/ | 5 |
| Beryllium, beryl concentrate, gross weight | | 23 | 23 | 4 | 4 e/ | 4 e/ |
| Chromium, chromite, gross weight | thousand tons | 522 | 252 | 517 | 707 r/ | 697 |
| Cobalt: 2/ | | | | | | |
| Mine output, Co content e/ | | 80 | 90 | 100 | 80 | 95 |
| Metal (hydroxide) | | 100 | 113 | 126 | 109 r/ | 110 |
| Columbium and tantalum, tantalite concentrate, gross weight | | 94 | 48 | 7 | 1 e/ | -- e/ |
| Copper: | | | | | | |
| Mine output, concentrate, Cu content e/ | thousand tons | 10 | 9 | 9 | 9 | 10 |
| Metal: | | | | | | |
| Smelter output, blister/anode, primary e/ | | 9,690 | 8,200 | 10,000 | 8,000 | 7,600 |
| Refinery output, refined/cathode, primary | | 9,673 | 8,187 | 9,350 | 6,875 | 10,900 |
| Gold | kilograms | 18,278 | 18,916 | 20,512 | 23,959 | 24,699 |
| Iron and steel: | | | | | | |
| Mine output, iron ore: | | | | | | |
| Gross weight | thousand tons | 1,179 | 375 | 4 | 311 | 324 |
| Fe content e/ | do. | 710 | 225 | 3 | 160 | 160 |
| Metal: | | | | | | |
| Pig iron e/ | do. | 507 | 211 | 100 | 209 3/ | 210 |
| Steel, crude | do. | 547 | 221 | 187 | 210 | 212 |
| Ferroalloys: | | | | | | |
| Ferrochromium | do. | 191 | 124 | 183 | 254 | 230 |
| Ferrosilicon chromium | do. | 20 | 30 | 36 | 47 | 51 |
| Ferromanganese | | -- | 2,151 | -- | -- | -- |
| Nickel: | | | | | | |
| Mine output, concentrate, Ni content | | 12,378 r/ | 12,769 r/ | 13,836 r/ | 11,721 r/ | 11,561 |
| Refinery output, refined metal 4/ | | 10,349 | 11,097 | 13,516 | 10,864 r/ | 9,694 |
| Platinum-group metals: | | | | | | |
| Palladium | kilograms | 19 | 11 | 17 | 20 r/ e/ | 120 e/ |
| Platinum | do. | 9 | 4 | 7 | 10 r/ e/ | 100 e/ |
| Selenium | do. | 1,736 | 1,113 | 2,009 | 2,000 e/ | 2,000 e/ |
| Silver | do. | 16,930 | 12,004 | 10,942 | 15,640 r/ | 9,982 |
| Tin: | | | | | | |
| Mine output, Sn content e/ | | 950 | 800 | 100 | 10 r/ | 10 e/ |
| Smelter output, metal | | 716 | 657 | 82 | -- | -- |
| INDUSTRIAL MINERALS | | | | | | |
| Asbestos | thousand tons | 150 | 157 | 152 | 169 | 165 |
| Barite | | 232 | 120 | -- | -- | -- e/ |
| Cement, hydraulic e/ | thousand tons | 900 | 1,000 | 1,070 r/ | 1,100 | 1,150 |
| Clays: | | | | | | |
| Bentonite (montmorillonite) | | 82,956 | 113,470 r/ | 169,097 | 169,823 r/ | 185,953 |
| Fire clay | | 15,954 | 9,257 | 13,997 | 12,743 r/ | 14,479 |
| Kaolin | | 83 | 90 | 462 | 57 r/ | -- |
| Diamond | carats | 40,654 | 43,850 | 173,588 | 204,416 r/ | 437,266 |
| Emerald | kilograms | 46 | 635 | 276 | 2,209 r/ | 1,080 |
| Feldspar | | 2,696 | 1,553 | 1,617 | 3,920 r/ | 3,248 |
| Graphite | | 12,346 | 7,142 | 7,890 | 11,381 | 7,691 |
| Kyanite | | 1,990 | 878 r/ | 567 | 875 r/ | 141 |
| Lithium minerals, gross weight | | 12,837 | 18,064 | 25,279 | 33,498 r/ | 30,929 |
| Magnesite | | 8,973 | 6,276 | 1,588 | 5,597 r/ | 10,659 |
| Mica | | 495 | 510 | 213 | 1,040 r/ | 1,500 |
| Nitrogen, N content of ammonia e/ | | 67,000 | 70,000 | 70,000 | 70,000 | 70,000 |
| Phosphate rock, marketable concentrate | thousand tons | 142 | 153 | 151 | 154 r/ | 123 |
| Pigments, iron oxide | | 538 | 390 | 438 | 400 | 400 e/ |

See footnotes at end of table.

TABLE 1--Continued

ZIMBABWE: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

| Commodity | | 1992 | 1993 | 1994 | 1995 | 1996 |
|---|---|---|---|---|---|---|
| INDUSTRIAL MINERALS--Continued | | | | | | |
| Stone, sand and gravel: | | | | | | |
| Granite | | 90,694 | 40,032 | 106,605 | 121,685 r/ | 109,268 |
| Limestone | thousand tons | 1,366 | 1,036 | 1,658 | 1,499 r/ | 1,425 |
| Quartz 5/ | do. | 77 | 61 | 131 | 172 r/ | 96 |
| Sulfur | | | | | | |
| Pyrite: | | | | | | |
| Gross weight | | 66,345 | 72,588 | 71,026 | 70,706 | 59,831 |
| S content e/ | | 29,200 | 32,000 r/ | 31,000 r/ | 31,000 r/ | 26,000 |
| Byproduct acid, metallurgical and coal process gas e/ | | 4,500 | 4,000 | 4,500 | 4,500 | 5,000 |
| Talc | | 2,203 | 1,349 | 2,049 | 2,080 r/ | 1,076 |
| Vermiculite | | 4,300 | 5,032 | 8,184 | 13,742 r/ | 10,249 |
| MINERAL FUELS AND RELATED MATERIALS | | | | | | |
| Coal, bituminous | thousand tons | 5,547 | 5,285 | 5,515 | 5,538 r/ | 5,175 |
| Coke, metallurgical e/ | do. | 500 | 200 r/ | 300 r/ | 300 r/ | 400 |

e/ Estimated. r/ Revised.

1/ Table includes data available through Feb. 14, 1998.

2/ "Mine output" figures are estimated from "metal" figures. "Metal" may include metal content of compounds/salts and may include cobalt recovered from nickel-copper matte imported from Botswana for toll refining.

3/ Reported figure.

4/ May include nickel content of nickel oxide.

5/ Includes rough and ground quartz as well as silica sand.

## TABLE 2
## ZIMBABWE: STRUCTURE OF THE MINERAL INDUSTRY FOR 1997

(Thousand metric tons unless otherwise specified)

| Commodity | | Major operating companies and major equity owners | Location of main facilities | Annual capacity |
|---|---|---|---|---|
| Asbestos | | Shabanie and Mashaba Mines (Pvt.) Ltd. [African Associated Mines (Pvt.) Ltd., 100%] | Shabanie Mine, Zvishavane; Gaths and King Mines, Mashava | 300 |
| Chromite, gross weight | | Zimbabwe Mining and Smelting Co. (Pvt.) Ltd. (Zimasco) (Zimasco Consolidated Enterprises, 100%) | Peak Mine and Railway Block Mine at Shurugui and mines at Mutorshanga and Lalapanzi | 500 |
| Do. | | Zimbabwe Alloys Ltd. (Zimalloys) (Anglo American Corp., 100%) | Great Dyke Mine, Mutoroshanga; Netherburn Mine at Lalapanzi; and Inyala Mine at Mberengwa | 50 |
| Do. | | Local Co-operatives | North Dyke | 50 |
| Coal | | Wankie Colliery Co. (Pvt.) Ltd. (private investors, 60%, Government, 40%) | Hwange | 5,500 |
| Cobalt | tons | Bindura Nickel Corp. Ltd. (Anglo American Corp., 100%) | Shangani Mine, northwest of Shangani; Madziwa Mine, 50 kilometers northeast of Bindura; Trojan Mine, Bindura; Epoch Mine, Filabusi | 150 |
| Copper | | Mhangura Copper Mines Ltd. (Zimbabwe Mining Development Corp., 55%) | Mhangura | 16 |
| Do. | | Munyati Mining Ltd. Co. (Reunion Mining PLC, 75%; Zimbabwe Mining Development Corp., 25%) | Sanyati Mine, Sanyati | 5 |
| Do. | | Lomagundi Smelting & Mining (Pvt.) Ltd. (Merits Ltd., 100%) | Smelter at Alaska | 35 |
| Do. | | do. | Refinery at Alaska | 28 |
| Diamond | carats | Auridam Zimbabwe (Pvt.) Ltd. (Auridam Consolidated NL, 50%; Redaurum Red Lake Mines Ltd., 50%) | River Ranch Mine, near Beitbridge | 440,000 |
| Gold | kilograms | Rio Tinto Zimbabwe Ltd. (RTZ Corp. PLC, 56%) | Renco Mine, 75 kilometers southeast of Masvingo; Patchway Mine, Kadoma; Brompton Mine, Kadoma; and Cam and Motor dump, Kadoma | 2,800 |
| Do. | do. | Ashanti Goldfields Zimbabwe (Pvt.) Ltd. (Ashanti Goldfields Co. Ltd., 82.4%, private investors, 17.6%) | Freda Rebecca Mine, Bindura | 2,500 |
| Do. | do. | Independence Mining (Pvt.) Ltd. (Lonhro PLC, 100%) | How Mine, Bulawayo; Athens Mine, Mvuma; Tiger Reef Mine, Kwekwe; Redwing Mine, Penhalonga; Shamva Mine, Shamva; Legion Dump, Kezi | 3,300 |
| Do. | do. | Falcon Gold Zimbabwe Ltd. (Falcon Investments S.A., 71.7%) | Dalny Mine, Chegutu; Venice Mine, Kadoma; Golden Quarry Mine, Shurugui; Old Nic Mine, Bulawayo | 2,000 |
| Do. | do. | Corsyn Consolidated Mines (Pvt.) Ltd. (Lonrho PLC, 100%) | Anzac Mine, Kwekwe; Arcturus Mine, Arcturus; Mazowe Mine, Mazowe; Muriel Mine, Mutorashanga | 1,500 |
| Do. | do. | Zimbabwe Mining Development Corp. (Government, 100%) | Lexington Mine and Elvington Gold Mine, near Chegutu | 1,000 |
| Do. | do. | Jena Mines (Pvt.) Ltd. [Zimbabwe Mining Development Corp., 50%; Trillion Resources (Pvt.) Ltd. Zimbabwe, 50%] | Jena Group, Kwekwe area | 400 |
| Do. | do. | Casmyn Mining Zimbabwe (Pvt.) Ltd. | Turk Mine, north of Bulawayo | 150 |
| Iron and steel: | | | | |
| Crude steel | | Zimbabwe Iron and Steel Co. (Pvt.) Ltd. (Government, 92%) | Redcliff, near Gweru | 220 1/ |
| Iron ore, gross weight | | Buchwa Iron Mining Co. [Zimbabwe Iron and Steel Co. (Pvt.) Ltd., 100%] | Buchwa West Mine, Buchwa; Ripple Creek Mine, near Redcliff | 1,400 |
| Ferroalloys: | | | | |
| Ferrochromium, high-carbon | | Zimbabwe Mining and Smelting Co. (Pvt.) Ltd. (Zimasco) (Zimasco Consolidated Enterprises, 100%) | Smelter at Kwekwe | 220 |
| Ferrochromium, low-carbon | | Zimbabwe Alloys Ltd. (Zimalloys) (Anglo American Corp., 100%) | Smelter at Gweru | 40 |
| Ferrochromium-silicon | | do. | do. | 55 |
| Lithium | | Bikita Minerals (Pvt.) Ltd. (private, 100%) | Bikita Mine, 60 kilometers east of Masvingo | 33 |
| Nickel | | Trojan Nickel Mines Ltd. (Bindura Nickel Corp., 100%) | Shangani, Madziwa, Trojan, and Epoch Mines | 17 |
| Do. | | Bindura Smelter & Refinery Ltd. (Bindura Nickel Corp., 100%) | Smelter and refinery at Bindura | 16 |
| Do. | | Rio Tinto Zimbabwe Ltd. | Empress Nickel Refinery, Eiffel Flats, northeast of Kadoma | 11 |

See footnotes at end of table.

## TABLE 2-Continued
## ZIMBABWE: STRUCTURE OF THE MINERAL INDUSTRY FOR 1997

(Thousand metric tons unless otherwise specified)

| Commodity | | Major operating companies and major equity owners | Location of main facilities | Annual capacity |
|---|---|---|---|---|
| Platinum-group metals | kilograms | Zimbabwe Mining and Smelting Co. (Pvt.) Ltd. (Zimasco) (Zimasco Consolidated Enterprises, 100%) | Mimosa Mines, east of Zvishavane | 300 |
| Phosphate | | Dorowa Minerals (Pvt.) Ltd. (Chemplex Corp. Ltd., 100%) | Dorowa Mine, 90 kilometers west of Mutare | 155 |
| Vermiculite | | Shawa Vermiculite (Pvt.) Ltd. (private, 100%) | Shawa Mine, near Dorowa | 39 |
| Do. | | Dinidza Vermiculite Mining Co. (Pvt.) Ltd. (private, 100%) | Dinidza Mine, near Dorowa | 10 |

1/ Blast furnace No. 4 (capacity: 780,000 metric tons per year) remained shut in 1996.

### THE MINERAL INDUSTRY OF

# OTHER COUNTRIES OF AFRICA

## By George J. Coakley, Bernadette Michalski, Philip M. Mobbs, and Ebraham Shekarchi

**Benin**[1]

The production of mineral commodities, primarily cement and crude petroleum, represented a minor part of the economy of Benin. *(See table 1.)* Benin's mineral commodity imports were dominated by refined petroleum products and clinker for cement.

Act No. 83-003 of May 17, 1983, was the Benin Mining Code. Decree No. 89-296 implemented the Code's regulations and Act No. 83-004 addressed fiscal policy affecting mineral development. The Government was deliberating an updated mining code. The Office Béninoise des Mines (OBEMINES), under the Ministry of Energy, Mining, and Hydraulics, had administered mineral developments in Benin. The Department of Mines was charged with promoting and developing the mineral sector. The Government controlled a majority interest in the Société des Ciments d'Onigbolo, the country's largest and only integrated cement plant. CIMBENIN and Société des Ciments du Benin were private clinker-grinding companies.

The Government continued its promotion of the country's natural resources to take advantage of the increased interest in West African exploration. However, the general state of the nation's transportation infrastructure has hampered development of inland mineral resources. Several private companies were negotiating for exploration permits for gold. On the petroleum front, Abacan Resources Corp. of Canada secured 50% of Addax Petroleum Ltd. of Switzerland's interest in offshore Block 1, proposing to explore the block from the adjacent Block 309 in Nigerian territorial waters. The Société Tarpon-Benin, a subsidiary of the Bettis Group of the United States, secured the contact to explore for petroleum on offshore Block No. 2.

A number of gold occurrences, placer and vein, had been identified in the Precambrian terrane in northwest Benin. Reserves of limestone near the cement facility at Onigbolo were sufficient to supply the plant at design capacity for more than a century. Other mineral resource development opportunities identified by OBEMINES included a number of deposits of brick and china clay along the coastal plain; feldspar at Idadjo and Tchaourou-Waria; the marble deposits at Idadjo, Atomè-Lonkly (Mono), and Lanta (Couffo); peat deposits adjacent to the Togo frontier; silica sand along the coast south of Porto Novo; and, in the north, the Loumbou-Loumbou iron-bearing deposit, the Mékrou phosphate deposit, and a number of potential ornamental stone quarrying sites. OBEMINES also documented occurrences of columbium-tantalum, industrial diamond, gypsum, mica, rare earths, rutile, tungsten, and zircon in Benin (Ministry of Energy, Mining, and Hydraulic, 1992).

**Burundi**[2]

Mineral commodity production remained a minor factor in the agriculturally dominated economy of inland Burundi. Minor quantities of gold, tantalum, tin, and tungsten minerals, kaolin, limestone, and presumably construction materials were produced. Expanding the output of gold and initiating production of nickel and associated platinum-group metals from a lateritic deposit and phosphate from a carbonatite-apatite deposit, remained of considerable interest. However, the July military coup signified continued ethnic and political tensions and consequently an unstable climate for mineral development by international investors despite the good geological potential for a substantial economic contribution from the minerals sector.

Nickel exploration by RTZ Corp. of the United Kingdom and Broken Hill Pty. Co. Ltd. (BHP) of Australia remained suspended. No activity was reported on the Butihinda and Muyinga gold deposits.

Government policy, laws, and regulations, including those specifically covering mining and petroleum in 1976 and 1979, were designed to attract private investment, particularly by foreign entities. A free-trade (import-export tax free) zone system covering the entire country, launched in 1993, offered many benefits to industrial and commercial ventures. However, minerals processing no longer qualified, according to a Government announcement in May 1995, which resolved a political controversy over the fact that a gold buyer-refiner, Affimet, was the only beneficiary. For a number of years, the Government promoted foreign support for several progressively more detailed studies aimed at exploiting nickel, gold, phosphate, peat and other mineral resources.

Environmental problems in mining apparently were not of much concern because of the small-scale operations.

The Ministry of Energy and Mines reported mineral production valued at about $9 million[3] in 1995 (Mathias Sebanhene, Director General of Geology and Mines, Ministry of Energy and Mines, written comm., 1996). (*See table 1.*) With the July military coup and the ensuing blockade, the value of mineral production in 1996 was most likely appreciably reduced.

---

[1] Text prepared May 1997 by Philip M. Mobbs.

[2] Text prepared July 1997 by Bernadette Michalski.

[3] Where necessary, values have been converted from Burundi francs (FBu) to U.S. dollars at the rate of FBu282=US$1.00.

The principal mineral commodity exports were gold, cassiterite, columbium-tantalite, and wolframite with destinations mostly to Europe; these were small compared with mineral imports, principally petroleum products, cement, steel, and fertilizer. During the first 7 months of 1996 and before the imposition of a blocade, exports included 2,256 kilograms (kg) of gold; 53.3 metric tons (t) of titanium oxide; 23.5 t of cassiterite; and 12 t of wolframite.

Infrastructure included an extensive domestic road network, although only a few were paved. Beyond the border, roads to available railheads were rather poor, except northward through Rwanda into Uganda and Kenya. By this route, the ocean port of Mombasa, Kenya, was about 2,100 kilometers (km) from Bujumbura. Lake vessels were a major mode of transportation, connecting Bujumbura with several railheads in Tanzania, Zaire, and Zambia. An international airport was at Bujumbura, but only a few other airstrips existed. Hydroelectric power was reasonably available in much of the country, with a potential for additional development. Telecommunications were limited.

The outlook for the minerals industry was for little change, pending resolution of the political situation. Hydropower potential and abundance of water were advantages, but export transportation, as well as infrastructural factors in general, were not favorable.

## Cape Verde[4]

Mining's contribution to the economy of Cape Verde was minimal. Most of the nation's mineral requirements were imported. Salt and volcanic rock were produced for local use. Salt was economically significant because one of its main uses was to preserve a portion of Cape Verde's fish harvest. The fishing industry has accounted for about 60% of the nation's export earnings in recent years. Other mineral deposits, formerly produced commercially but abandoned as noneconomic, include gypsum, kaolin, and dimension stone.

## Comoros[5]

The Federal Islamic Republic of the Comoros has a total area of 2,170 square kilometers (km$^2$), located on three main islands, in the Mozambique Channel about two-thirds of the way between northern Madagascar and northern Mozambique. It had a 1996 population of 570,000 and a gross domestic product (GDP) per capita, last estimated in 1994 at $700.

The mineral industry of Comoros continued to be limited to the production of common construction materials, such as clay, sand, gravel, and crushed stone for local consumption. Quantities were not available but were presumably very low because there were no significant construction projects noted in the press since the early 1980's. Geothermal energy was considered a possibility for development. However, the outlook on minerals output was for no significant change. The former French colony was totally dependent on imports to meet its energy needs.

The economy of Comoros is based on the export of agricultural products, chiefly spices. Political instability in recent years has continued to have a negative affect on the economy.

## Djibouti[6]

The few reports available in recent years on mineral industry activity in Djibouti indicated intermittent entrepreneurial production of small quantities of solar-evaporated sea salt, limestone (some of which was at least periodically calcined to lime), and construction materials, including clays, sand, gravel and crushed stone, as well as some marble and granite dimension stone. However, other mineral occurrences of economic interest include diatomite, geothermal fluids and mineral salts, gold, gypsum, perlite, pumice, and possibly petroleum. Most of these are near Lake Asal, although some gold indications were further west near Yoboki and in the south near Ali Sabieh. Oil interest was focused in the south and offshore in the Gulf of Aden.

The Government was trying to attract foreign investment to develop the mineral industry. However, no major changes in the status of the mineral industry were expected in the immediate future.

## Equatorial Guinea[7]

The Republic of Equatorial Guinea consisted of the volcanic island of Bioko in the Gulf of Guinea and Rio Muni on the African mainland. Decree No. 9/1981 regulated mining activity, except aggregate and radioactive minerals. Mineral resources were the property of the state. Production was subject to a 5% royalty rate. Petroleum exploration and production in Equatorial Guinea were controlled by the Decree No. 7/1981, pursuant to the earlier Hydrocarbons law (Model of Agreement), section II, paragraph 2.8 (E). Production-sharing agreements initially credited the state with 10% of output.

Several mineral and geologic surveys have been conducted in recent years by various organizations. In 1975, the Soviets assessed Rio Muni's bauxite, gold, iron, and radioactive minerals. In the early 1980's, Guineo Españo de Minas S.A. conducted aero-magnetic and aero-radiometric surveys and ground exploration. From 1981 to 1985, France's Bureau de Recherches Géologiques et Minières (BRGM) identified occurrences of bauxite, copper, alluvial gold, ilmenite beach sands, lead, phosphates, and zinc in Rio Muni.

UMC Equatorial Guinea Corp., a subsidiary of United Meridian Corp. of the United States, was entered an exclusive 33-month mineral development agreement for the entire Rio Muni area in March 1996. During 1996, UMC conducted reconnaissance sampling for a gold exploration program and was pursuing partners for joint ventures on its Rio Muni concession (UMC Equatorial Guinea Corp., 1997).

CMS NOMECO Oil & Gas Co. of the United States had acquired the Equatorial Guinea operations of Walter

---

[4] Text prepared May 1997 by Philip M. Mobbs.

[5] Text prepared August 1997 by George J. Coakley.

[6] Text prepared May 1997 by Philip M. Mobbs.

[7] Text prepared July 1997 by Philip M. Mobbs.

International Inc. of the United States during 1995. CMS NOMECO effectively increased its working interest in the Alba gas-condensate field in the Gulf of Guinea, 36 km offshore of Bioko from 16.67% to approximately 35%. Samedan Oil Corp. held 34.8% interest in the consortium, and Globex International and Axem Resources held the remaining interest. CMS NOMECO was constructing a 3-million-cubic-meter-per-year liquefied petroleum gas plant in Equatorial Guinea to process production from Alba. Natural gas from the field had been flared since condensate production began in 1991.

Mobil Oil Equatorial Guinea Inc. (75%), a subsidiary of Mobil Corp. of the United States, and UMC (25%) continued development of the offshore Zafiro prospect. The companies had a 268,000 deadweight-ton tanker converted into a floating production, storage, and offloading (FPSO) vessel. Oceaneering Production Systems of the United States operated floating facility. Two processing lines with a total 80,000-barrel-per-day (bbl/d) capacity were installed and the FPSO has a storage capability of approximately 1.2 million barrels. Production from Zafiro Field began on August 25, 1996.

The Mobil and UMC venture was actively drilling exploration and development wells on Block B. During 1996, the Zafiro-4 and -5 were drilled; as well as the Topacio-1 and -2, approximately 5 km to the south; the Rubi-1, 4 km southeast of Zafiro-1; the Amatista-1; and the IQI-105 (re-designated the Jade-1), 5 km to the southeast. Being drilled at yearend were the Zafiro-6 and the Azurita-1. UMC (75%) and Yukong Ltd. of the Republic of Korea (25%) were reviewing data on their Block C and Block D leases, with water depths ranging from 150 to 750 meters (m). On Block D, the partnership was drilling the Perla-1 at yearend.

## Lesotho[8]

Lesotho has long been known as a source of diamonds, mostly from alluvial deposits. In recent years, 33 kimberlite pipes and 140 kimberlite dykes, of which 24 are diamondiferous, have been identified by the Lesotho Geological Survey. The Liqhobong Kimberlites Complex, northeast of Lesotho, is one of three areas in which Messina Corporation of Canada carried on an intensive exploration program during 1996. The first phase of exploration that covered an area of approximately 400 hectares was accomplished at a cost of $2.5 million, which included detailed mapping and sampling. The sampling was done on two kimberlite pipes. The main pipe covering about 9.5 hectares (ha) and the satellite pipe covering approximately 1.6 ha, are connected by a narrow, 1 meter wide, dyke. According to a February 4, 1997 press release of Messina Diamond Corp., the preliminary evaluation of samples collected in 1996 indicate a high-grade kimberlite at the satellite pipe and a medium-to-high grade kimberlite at the main pipe which, when combined with the large tonnage, give the project a potential to be pursued in 1997. The second phase of the exploration, a major bulk sampling, was planned for 1997 that will provide large parcels of Liqhobong stones for evaluation prior to commencement of the feasibility study.

Liqhobong Kimberlite Complex is situated northeast of the Lesotho Highlands Water
Development Project (HWP) in the Maluti mountains. The first dam of this project was completed during 1996. Total cost of HWP, which is provided by World Bank, is estimated at $4 billion.

Lesotho produced, for domestic consumption, a small amount of crushed stone, clay, and sand and gravel. Diamond production during the year was 1,500 carats, which was mined primarily by rudimentary methods.

## Liberia[9]

The mineral economy of Liberia continued to be adversely affected by the civil war that started in 1989. Negotiations between the opposing parties resulted in a peace accord during 1995. The agreement subsequently collapsed as had prior cease-fires.

Mineral production consisted mainly of artisanally mined diamonds and gold. *(See table 1.)* Many of the diamonds exported from Liberia were believed to have come from other West African countries.

## Malawi[10]

The Republic of Malawi is a landlocked country surrounded by Mozambique, Tanzania, and Zambia. It has an area of 119,140 km$^2$ of which 20% is Lake Malawi. With a population of about 10.7 million in 1996, Malawi's per capita GDP was estimated by the U.S. Embassy at $193. The economy of Malawi is based mostly on agriculture, which contributes to 35% of the GDP and for over 90% of total export earnings (U.S. Embassy, Lilongwe, 1997). The mineral sector contributed modestly to the economy and accounted for an estimated 3% of the GDP in 1996. Production of cement, coal, crushed stone for aggregates, dolomite, limestone, and some artisanal salt production was consumed locally. *(See table 1.)* Malawi also produced small amounts of lime. The Department of Mines also reports that some companies are producing various gemstones like (in order of volume) rubies, sapphires, aquamarine, amethyst, garnet, agate and corundum on a small scale and at organized levels (Malawi Ministry of Energy and Mines, 1997). Coal, from the Mchenga Mine, and limestone produced in Malawi were essential components of the country's cement and lime industries. The production of stone for aggregate and cement was the largest component, by value, of Malawi's mineral production.

The country has known mineral deposits of apatite, aquamarine, bauxite, corundum, glass sand, granite, graphite, kaolin, kyanite, phosphates, pyrite, tourmaline, uranium, and vermiculite. Current exploration efforts are directed toward deposits of base metals, diamond, garnet, gold, rare earths, and rutile and ilmenite sands.

Mineral activities are covered by the Mines and Minerals Act, 1981; the Mines and Minerals (Mineral Rights) Regulations,

---

[8] Prepared June 1997 by Ebraham Shekarchi.

[9] Text prepared May 1997 by Philip M. Mobbs.

[10] Text prepared August 1997 by George J. Coakley.

1981; and the Petroleum (Exploration and Production) Act of 1983. All minerals are vested in the President on behalf of the people of Malawi. The Ministry of Energy and Mines is authorized to negotiate incentives and benefits with investors. The Government encourages local and foreign investment and anticipates that mining would diversify the Nation's economy from its agricultural base. The preferred methods of investment in Malawi are joint ventures or the establishment of local subsidiaries.

Three types of mining licenses are issued in Malawi for small-mining operations, 1) the mineral permits/rights; for larger operations, 2) the exclusive prospecting licenses, and 3) mining licenses (which are submitted to the Commissioner for Mines and Minerals to be considered by the Licensing Committee). According to the Minister of Energy and Mines, processing time for the mining license is 2 months (U.S. Embassy, Lilongwe, 1996). All mining licenses can be transferred. In addition to the Ministry of Energy and Mines, the Mining Investment and Development Corp. (MIDCOR) is the Government holding company responsible for overseeing the mining sector. Environmental provisions in the Mines and Minerals Act, a result of Malawi's review of its environmental concerns in June 1994, included the requirement that the Department of Research and Environmental Affairs review an environmental impact assessment with each mineral rights application (United Nations Development Programme, 1995).

In 1996, the Government began a process of privatizing a number of state-owned corporations. Among the first of these was the government sale of 51% of its share of the Portland Cement Company Ltd. (PPC) to the Commonwealth Development Corp. of the United Kingdom (CDC). As Malawi's only cement producer, PCC operates from two main sites; at Changalume, where the limestone quarry and kilns are located, and at Blantyre, 70 km to the south, where the clinker grinding and final packaging is done. CDC planned to invest $16.5 million in 1996 and an additional $8.9 million in 1998 to expand and upgrade the quarry operations and main kiln. CDC planned to expand production from 125,000 metric tons per year (t/yr) to 180,000 t/yr by the year 2000 (International Cement Review, 1996).

A 1994 African Development Bank study identified a bauxite reserve of around 28 million metric tons (Mt) averaging 43.9% aluminum oxide at Mulanje Mountain, for which the Government, in 1996, was actively seeking investment to develop an integrated mine and alumina plant and possibly an aluminum smelter. Gencor Ltd. of South Africa indicated an interest in purchasing alumina from any potential project for its subsidiary, ALUSAF Ltd.'s aluminum smelter in Richards Bay, South Africa (Mining Journal [London], 1996).

Renewed interest in the mining sector included MIDCOR's study of the flake graphite deposit at Katengeza in the Dowa District. MIDCOR also was looking for joint-venture investors to develop the Ngana coal, Bwanje Valley high-calcitic marble, precious and semiprecious stones, and apatite deposits. The apatite would be used as a feed for the country's fertilizer industry. The Ministry of Energy and Mining also estimated total coal reserves of more than 800 Mt. Caledonia Mining Corporation of Canada acquired an 8.4 km$^2$ prospecting license covering the Kangankunde Hill carbonatite complex about 50 km north of Blantyre. MIDCOR reported that BRGM of France studies of the carbonatite showed that there are " 2 Mt of possible reserves at 6.6% monazite and 546,000 tons of minable reserves averaging 10.3% monazite. Drill indicated reserves amount to 11 Mt of ore grading 2.0% rare-earth oxides and 8% strontianite" (Malunga, 1997).

### Mauritius[11]

The Republic of Mauritius is a small island nation of 1,860 km$^2$, located about 1,000 km east of Madagascar. It has population of 1.14 million and a healthy GDP per capita, last estimated in 1995, of $9,600.

The mineral industry of Mauritius was a negligible factor in the economy which is based chiefly on tourism and the export of sugar and textiles. As a participating member of the Uruguay Round and the World Trade Organization, Mauritius lost its preferential trade status in several of its major export markets, which negatively impacted the economy of Mauritius in 1995 (World Trade Organization, 1995). Mauritius expanded its tourism sector and was trying to position itself as a regional financial hub in 1995. It maintained a favorable foreign investment climate and a Free Port Authority.

Historically, mineral output consisted of the local production and use of basalt construction stone, coral sand, lime from coral, and solar-evaporated sea salt. Quantitative information was rarely available and then appeared to be inconsistent. Data on production of mineral commodities were not available, but based on past activity Mauritius produces about 7,000 t/yr of lime, 6,000 t/yr of salt, 300,000 t/yr of sand, and 1,000,000 t/yr of stone. Environmental concerns were being raised over the mining of coral sand and its impact on coastal lagoons. Sand made from crushing basalt rock was used as a substitute for natural sand in construction materials.

Polymetallic nodules occurred on the ocean floor at about 4,000 m depth, extending from 400 km to 800 km north of Port Louis, northeast of Tromelin Island. The nodules averaged more than 15% each of iron and manganese and more than 0.3% cobalt, with an abundance averaging from 2 to 6 kg per square meter. The abundance of land-based resources of these commodities made it unlikely that these resources would be developed in the foreseeable future.

While the country is totally dependent on imports for its energy requirements, oil possibilities were of interest east of the polymetallic nodules area at shallower depth. The area was inconclusively explored with geophysics and drilling by Texaco in the 1970's. Mbendi Information Services of South Africa reports energy consumption coming from electricity (10.5%), coal (5.4%), and oil-derived products (84.1%). Mauritius consumed about 570,000 tons of oil products in 1993 and was growing at a rate of about 7% per year (Mbendi Information Services, 1995). Bids were being sought during 1996 to conduct a feasibility study for a 5-megawatt irrigation-hydroelectric dam in Midlands (Africa Energy & Mining, 1996).

Steel reinforcing bars were made from imported ingot at three rolling mills. The near-term outlook for the exploitation of minerals other than construction materials was negligible.

---

[11] Text prepared August 1997 by George J. Coakley.

### Reunion[12]

Reunion, an overseas department of France, is a small island of 2,510 km$^2$, located about 650 km east of Madagascar. It has population of 680,000 and a gross national product per capita estimated in 1995 at $4,300. It has an agricultural economy dominated by sugar cane exports. In 1996, France began to promote investment in Reunion for value added products that would have duty-free export access to European Union markets.

Mineral commodities production represented only a small part of the economy of Reunion in 1995 as in prior years, even though little quantitative information was available. However, output of hydraulic cement, made by grinding imported clinker, presumably remained substantial, well above 300,000 t/yr. The plant, owned by Ciments de Bourbon S.A. at Le Port, had a capacity of 350,000 t/yr. Additionally, production of basic volcanic rock and sea coast coral undoubtedly continued to meet the needs of construction. Little change in future mineral activity was anticipated.

### Rwanda[13]

The mineral industry, principally the mining of columbium-tantalum, tin, and tungsten ores, made only a very minor contribution to Rwanda's economy. Agricultural products, principally coffee and tea, provided the bulk of export earnings while the mineral industry contributed less than 10% to total exports valued at $40 million. Mineral commodity imports, predominantly petroleum products, structural steel, and cement constituted about 25% of total imports valued at $250 million. Trade was mostly with the United States and Europe. Rwanda has no crude oil reserves or refinery activities, importing all of its commercial energy in the form of refined petroleum products from Kenya and Tanzania. Petroleum product consumption is less than 2,000 bbl/d. Gasoline and diesel were the principal petroleum imports; however, heavy fuel oil, consumed by a few industrial units, accounted for about 15% of petroleum imports. The price of gasoline and diesel is determined by the Government, however, other petroleum products are not controlled. Most of the distribution and marketing of fuels was conducted by the following privately owned companies: Enterprise Rwandaise de Petrole, Societe Generale de Petrole, and Rwanda Petrolgaz. The Government is a major equity holder in PetroRwanda which enjoys a market share of approximately 25%.

The structure of the industry consisted mostly of a number of small cooperatives and individual artisanal miners that produced the concentrates of tin, tungsten, columbium-tantalum, and gold ores from scattered locations, generally in a zone about 30 km wide extending east-west through Kigali. Mineral production data were estimated. *(See table 1.)* Mineral reserves data were not available.

Transportation was tied to the internal network of paved roads. Rwanda must rely on neighboring states for access to seaports on the Indian Ocean 1,500 km east of Kigali at Mobassa (Kenya) and Dar es Salaam (Tanzania). Typical c.i.f delivered costs of imports were 30% higher than f.o.b. vessel in port. There were no railroads in Rwanda, but several terminals were located about 400 km from Kigali—north in Uganda, and south and southeast in Tanzania. Lake Kivu, navigable by shallow-draft barges, provided low-cost transportation to a limited area, and the international airport at Kigali was an important factor in the transportation picture.

Ample hydroelectric power was advantageous to further industrial and mine development. However, the electrical distribution system was still rather limited. For several years, Rwanda was only able to generate 60% of the country's electricity requirement. The diesel-powered Ntakura electric powerplant has been down since 1993.

Environmental problems at the many small mines were known to exist, but economic conditions were not conducive to their resolution. The outlook on mineral production was for a gradual return to pre-1994 conditions as, and if, the political situation stabilized. In view of continued civil unrest, significant changes were not likely for some time.

### São Tomé e Principe[14]

The Democratic Republic of São Tomé e Principe is a dual island Nation south of Nigeria and west of Gabon on the Equator in the Atlantic Ocean. The country's mineral production encompassed some small clay and stone open pit operations supplying local construction needs. All other minerals and refined petroleum products were imported.

### Seychelles[15]

The Republic of Seychelles is a group of 40 granitic and 50 or more coralline islands with a total area of 455 km$^2$, located in the Indian Ocean, northeast of Madagascar. It has population of nearly 73,000 and a GDP per capita of $6,000. The economy is based on tourism.

Mineral production in Seychelles consisted mostly of unspecified quantities of construction materials—clay, coral, stone, and sand. Output of guano, an organic phosphate fertilizer composed of bird droppings, ceased in the mid-1980's, but a 5,000-t/yr-capacity remained; occasional small production was unofficially reported.

Granite in the bedrock of Mahe and nearby islands had some economic potential. It was quarried for dimension stone on a trial basis by an Italian firm in the early 1980's. In 1992, Gondwana Granite, a South African company, was granted a license to extract and export up to 3,000 cubic meters of granite. Tile and statuary products were the most likely end uses. Lime and cement production from the abundant coral also continued to be considered. However, preservationists and other environmentally concerned groups opposed both the granite and coral use projects.

---

[12] Text prepared August 1997 by George J. Coakley.

[13] Text prepared July 1997 by Bernadette Michalski.

[14] Text prepared May 1997 by Philip M. Mobbs.

[15] Text prepared August 1997 by George J. Coakley.

Polymetallic nodules were known to occur on the ocean bottom near the Admirante Islands. Limited sampling was done in the mid-1980's, but funds for further planned work were not available.

The oil potential of the entire Seychelles region continued to be promoted by the Government-owned Seychelles National Oil Company (SNOC) through the Petroleum Mining Act of 1976. Tar balls from subsurface seeps were known for many years to occur on beaches of Coetivy Island, as well as on Mahe and some nearby islands. Exploration began in 1969, and up to 1994, 23,150 km of seismic profiles and 27,911 km of aeromagnetic lines had been accumulated. In the early 1980's, Amoco drilled three wells about 150 km west of Victoria, each of which showed evidence of hydrocarbons, but gave up its acreage when oil prices dropped. In the late 1980's, several other companies acquired exploration rights in the Seychelles: Enterprise Oil PLC, a British major oil firm, in the southeast, and Texaco of the United States and Lasmo PLC of the United Kingdom in the north and west. Enterprise reportedly undertook a $10 million drilling test in 1995 on its 10,000-(km$^2$) offshore concession, 200 km southeast of Victoria. Mbendi Information Services of South Africa reported that Enterprise Oil's offshore appraisal well in the southern Constant Bank was declared dry in August 1995 (Mbendi Information Services, 1996). A comprehensive 1996 report on the Seychelles geology, hydrocarbon potential, historical exploration activity, geophysical data availability, and the terms of SNOC's Model Petroleum Agreement are available through the Mbendi Internet site.

Petroleum could well play a larger role in the future economy of the Seychelles.

## Somalia[16]

Continued political instability extended the Somali minerals industry's historically insignificant influence in the nation's economy. For a number of years, officially reported mineral production and trade data have not been available. The country was one of the world's least developed, and prior to the authoritarian Government's overthrow early in 1991, all of industry—with minerals production being only a small part—was estimated typically to contribute less than 10% to the nation's GDP.

The structure of the mineral industry prior to 1991 consisted of a 10,000-bbl/d petroleum refinery at Mogadishu and a 200,000-t/yr cement plant near Berbera, both operated by parastatals; and a 1,500 t/yr plaster (calcined gypsum) production facility near Berbera, plus a number of small marine salt, sepiolite (meerschaum), and crude construction material producers at various locations, all believed to be privately owned and operated. A few tens of tons per year of meerschaum was the only noteworthy mineral export commodity.

Mineral production presumably continued in a limited way during 1996, despite the political situation, because of the artisanal nature of salt and meerschaum production. The cement and gypsum plants in Berbera, in the relatively stable, unrecognized, breakaway republic which calls itself Somaliland may have increased production. (*See table 1.*)

Infrastructure was rather limited. The transport system was poor, with no railroad and the 5,000-km road network in need of repair. There were three main sea ports at Berbera, Chisimaio, and Mogadishu.

## Sudan[17]

Mineral commodities produced in Africa's largest country included cement, chromite, crude construction material, crude oil, gold, gypsum, limestone, petroleum refinery products, and salt. Although the quantities were small in the world view and the industry contributed very little to Sudan's economy, the country had some potential for increasing output of oil and gas, gold, and chromite, as well as for reviving production of manganese ores and several industrial minerals. Although minerals typically provided less than 1% of export revenues, mineral commodity imports, principally petroleum refinery products, crude oil, fertilizer, and structural steel constituted a significant proportion of total imports.

The 13-year-old civil war in the south adversely affected petroleum exploration in the region. The Sudan People's Liberation Army declared international exploration activity to be a military target (Journal of Commerce, 1997).

Sudan had been under sanction by the United States Government since 1993 when Sudan had been placed on its list of state sponsors of terrorism. The Antiterrorism and Effective Death Penalty Act of April 1996 prohibited American companies from entering into financial transactions with Sudan; however, Sudan was excepted from the Act in August 1996 (Washington Post, 1997). Beginning in April 1996, members of the Sudanese Government were subject to travel constraints under United Nations Resolution 1054 and United Nations Resolution 1070 restricted international flights by the Government's Sudan Airways.

Government policy codified in the Investment Encouragement Act of 1980 encouraged foreign investments, especially in minerals. That Act and the Mines and Quarries Act of 1972 and Regulations of 1973, together with the Petroleum Act and Regulations of 1972 and 1973, respectively, appeared to be the principal laws affecting the minerals industry, except for radioactive minerals and precious stones, which were treated separately.

The structure of the mineral industry consisted of mostly rather small companies, often producing intermittently, although gold and oil possibilities were attracting larger foreign companies into at least some exploration. State-owned companies had become significant in the early 1970's and remained the sole producers of cement and oil refinery products. Private firms began operating again in 1979.

The only known gold producer, Ariab Mining Co., was owned 60% by the Government's Sudanese Mining Co. and 40% by the Mine Or S.A., an affiliate of LaSource Compagnie Minière. Ariab expanded its treatment plant's processing capacity to 220,000 t/yr to handle increased output from the Hadal Avatil and Baderuk pits. (*See table 1.*)

---

[16] Text prepared July 1997 by Philip M. Mobbs.

[17] Text prepared July 1997 by Philip M. Mobbs.

Gold prospecting licenses were the subject of negotiations between the Government and several international companies during 1996. Mine Or and Bulgarian and Chinese companies were actively pursuing gold exploration opportunities.

Crude oil production by Government's Public Petroleum Corp. and/or Romania's Rompetrol Group was reported in the Abu Ghabra area, about 750 km southwest of Khartoum. The Government operated a small 2,000 bbl/d refinery at Abu Ghabra.

State Petroleum Corp., a subsidiary of Arakis Energy Corp. of Canada, began production in April 1996 from wells in the Heglig Field. Crude oil production was trucked to the railroad and transported to the refinery at El-Obeid. The 10,000-bbl/d refinery was commissioned in July 1996. In December 1996, Arakis, China National Petroleum Corp., Petronas Carigali Sdn. Bhd. of Malaysia, and the Government agreed to fund the proposed pipeline from the Heglig and Unity Fields in the Muglad Basin to a new terminal to be built south of Port Sudan (Arab Petroleum Research Center, 1997).

Gulf Petroleum Corp. of Qatar, National Oil Co. of Sudan, and Concorp Ltd. of Sudan were working to develop the Adar-Yail Field. In January 1996, International Petroleum Sudan Ltd., a subsidiary of Red Sea Oil Corp. plugged and abandoned the offshore Suakin-2 well. Total Exploration, a subsidiary of Total S.A. of France, has suspended exploration operations on two onshore blocks since 1985 because of the civil war.

Reserve data on minerals in the Sudan were not considered sufficiently reliable for publication.

Infrastructure problems in the country were severe. Roads were the primary transportation mode and were badly in need of repair. A 4,800-km railway network linked major cities, but was in poor condition and carried only a fraction of the tonnage it had in the early 1970's. A refined petroleum products pipeline 800 km from Port Sudan to Khartoum operated much below capacity. Port Sudan and nearby Suakin were deepwater ports on the Red Sea.

Electric power shortages were not uncommon, and studies on generation and distribution improvements were a focus of foreign aid. Hydropower was an important component, but liquid-fueled steam-turbine units were widely used. An additional thermal plant north of Khartoum and new hydro dams and facilities were also being planned.

The outlook for development of additional oil production appeared promising. Increased chromite and gold output also was probable. However, the political climate and continued economic instability were likely to deter major international efforts at further exploiting the remaining mineral potential of Sudan for some time. The generally poor infrastructure was an additional obstacle to any significant mineral production increases.

### References Cited

Africa Energy & Mining, 1996, New start for Midlands project?: Paris, Africa Energy & Mining, Indigo Publications, no. 188, September 11, p. 6.

Arab Petroleum Research Center, 1997, Arab oil & gas directory: Paris, Arab Petroleum Research Center, p. 399-408.

International Cement Review, 1996, Malawi's secure cement future: International Cement Review, September, p. 89-90.

Journal of Commerce, 1997, Sudan rebel group warns—All foreign oil firms targets: Journal of Commerce, March 3, p. 5B.

Malawi Ministry of Energy and Mines, 1997, Mineral Potential of Malawi—Opportunities for mineral investment: Malawi Ministry of Energy and Mines, May, p. 8.

Malunga, G.W.P., 1997, Mineral potential of Malawi: Lilongwe, Malawi, Mining Investment and Development Corp. Ltd., January, 14 p.

Mbendi Information Services, 1995, Mauritius—Oil industry profile: Mbendi Information Services, November 18, 1995 (Accessed August 13, 1997, on the World wide web at URL http://mbendi.co.za/cymroi.htm)

———1996, Seychelles oil industry profile: Mbendi Information Services, February 13, 1996 (Accessed August 21, 1997, on the World wide web at URL http://mbendi.co.za/cyseoius.htm)

Mining Journal (London), 1996, Malawi alumina tempts Gencor: Mining Journal, v. 325, no. 8381, May 31, p. 418.

Ministry of Energy, Mining, and Hydraulics, 1992, Benin mining resources: Cotonou, Benin, Ministry of Energy, Mining, and Hydraulics, 23 p.

UMC Equatorial Guinea Corporation, 1997, Rio Muni minerals concession: (Houston), UMC Equatorial Guinea Corporation, (unpaginated).

United Nations Development Programme, 1995, Sustainable development networking program in Malawi project document, August 6, 1996. (Accessed May 21, 1997, on World Wide Web at URL http://192.124.15/sdnp/of/malawi/html ASCII (text) format)

U.S. Embassy, Lilongwe, Malawi, 1997, FY 1997 country commercial guide: U.S. Embassy, Lilongwe, Malawi, August 1996 (Accessed August 12, 1997, on the World Wide Web at URL http://www.state.gov/www/about_state/business/com_guides/africa/malawi97.html. ASCII text format).

———1996, Malawi's mineral potential: U.S. State Department Airgram Lilongwe 002915 (July 15, 1996), 3 p.

Washington Post, 1997, U.S. eased law on terrorism to aid oil firm: January 23, p. A1.

World Trade Organization, 1995, Trade policy review: Mauritius, Minutes of October 17-18, 1995 meeting of the WTO Trade Policy Review Body, Report WT/TPR/5, December 14, 1995, 22p.

### Major Sources of Information

Ministère de l'Energie, des Mines et de l'Hydraulique
Department of Mines
04 B.P. 1412
Cotonou, Benin
Telephone: (229) 31-29-07
Fax: (229) 31-35-46
Ministry of Industry, Energy and Mining
P.O. Box 175
Djibouti, Djibouti
Telephone: (253) 350-340
Fax: (253) 350-174
Ministerio de Minas y Energia
Departmento de Minas y Hydrocarburos
B.P. 778
Malabo, Equatorial Guinea
Telephone (240) 9-2086
Fax: (240) 9-3353
Departments of Mines and Geology
Ministry of Water, Energy and Mining
Maseru, Lesotho
Ministry of Energy and Mines
The Principal Secretary
Private Bag 309
Lilongwe, Malawi
Telephone: (265) 781-255 or 781-960
Fax: (265) 784-236
Department of Mines, Director
P.O. Box 251
Lilongwe, Malawi

Telephone: (265) 722-194 or 722-933
Fax: (265) 722-772
Geological Survey Department, Director
P.O. Box 27
Lilongwe, Malawi
Telephone: (265) 522-166
Fax: (265) 522-716
Mining Investment and Development Corp Ltd.
The General Manager
P.O. Box 565
Lilongwe, Malawi
Telephone: (265) 741-664
Fax: (265) 743-768
Ministry of Energy and Mining
P.O. Box 2087
Khartoum, Sudan
Telephone: 755-95
Telex: 22256

## TABLE 1
## OTHER COUNTRIES OF AFRICA: PRODUCTION OF MINERAL COMMODITIES

(Metric tons unless otherwise specified)

| Commodity | | 1992 | 1993 | 1994 | 1995 | 1996 e/ |
|---|---|---|---|---|---|---|
| BENIN 1/ 2/ | | | | | | |
| Cement, hydraulic e/ | | 370,000 | 380,000 | 380,000 | 380,000 | 380,000 |
| Petroleum, crude | thousand 42-gallon barrels | 931 | 950 e/ | 884 | 570 e/ | 1,000 |
| Steel, crude e/ | | 8,000 | 2,000 3/ | -- | -- | -- |
| BURUNDI 4/ | | | | | | |
| Clays: Kaolin | | 9,690 | 5,000 e/ | 2,331 | 4,766 | 4,500 |
| Columbium-tantalum, mine output, ore (30% $Ta_2O_5$): | | | | | | |
| Gross weight e/ | kilograms | 30,000 | -- | 90,000 | 160,000 | 200,000 |
| $Ta_2O_5$ content | do. | 8,527 | -- | 26,125 | 46,692 | 60,000 |
| Gold e/ | do. | 32 | 20 | 1,000 r/ | 2,000 r/ | 2,200 |
| Lime e/ | | 182 5/ | 150 | 150 | 200 | 200 |
| Peat e/ | | 12,000 5/ | 10,000 | 10,000 | 10,000 | 10,000 |
| Tin, mine output, ore ( 60% $SnO_2$): | | | | | | |
| Gross weight e/ | kilograms | 183 5/ | 100 | -- | 25 | 45 |
| Sn content e/ | do. | 110 | 60 | -- | 15 5/ | 25 |
| Tungsten, mine output, ore (65 % $WO_3$) | | | | | | |
| Gross weight e/ | kilograms | -- | -- | -- | 42,500 | 30,000 |
| $WO_3$ content | do. | -- | -- | -- | 27,493 | 20,000 |
| LIBERIA 1/ 6/ | | | | | | |
| Cement, hydraulic | | 8,282 | 8,300 e/ | -- | -- e/ | -- |
| Diamond e/ | carats | 150,000 | 150,000 | 100,000 | 150,000 | 150,000 |
| Gold e/ | kilograms | 700 | 700 | 700 | 800 | 700 |
| Iron ore | thousand metric tons | 1,742 | -- | -- | -- e/ | -- |
| MALAWI 7/ 8/ 9/ | | | | | | |
| Cement, hydraulic | | 112,000 | 127,000 | 121,954 | 138,675 | 140,000 |
| Coal | | 39,200 | 52,800 | 34,630 | 14,635 | 20,000 |
| Dolomite e/ | | 2,500 | 2,000 | 1,321 5/ | 876 5/ | 700 |
| Gemstones: Ruby and sapphire e/ | kilograms | 20,000 | 20,000 | 21,454 5/ | 75,588 5/ | 100,000 |
| Lime e/ | | 4,000 | 2,560 | 3,544 5/ | 1,119 5/ | 2,000 |
| Stone: | | | | | | |
| Crushed for aggregate | | 420,000 | 380,308 | 65,039 | 65,601 | 456,000 |
| Limestone, for cement | | 175,000 | 126,000 | 173,758 | 175,578 | 133,648 5/ |
| RWANDA e/ 10/ 11/ | | | | | | |
| Cement | | 60,000 | 60,000 | 10,000 | 10,000 | 10,000 |
| Columbite-tantalite, ore and concentrate: | | | | | | |
| Gross weight | kilograms | 100,000 | 100,000 | 10,000 | 149,000 | 100,000 |
| Cb content | do. | 34,000 | 34,000 | 3,400 | 40,000 | 30,000 |
| Ta content | do. | 22,000 | 22,000 | 2,200 | 28,000 | 25,000 |
| Gold, mine output, Au content | do. | 1,000 | 1,000 | 100 | 26 | 25 |
| Tin, mine output, Sn content | | 500 | 400 | 50 | 242 | 200 |
| Tungsten, mine output, W content | | 175 | 175 | 30 | 47 | 40 |
| SOMALIA e/ 12/ | | | | | | |
| Cement, hydraulic | | 25,000 | 25,000 | 25,000 | 25,000 | 30,000 |
| Gypsum | | 2,000 | 2,000 | 2,000 | 2,000 | 2,000 |
| Limestone 13/ | | 40,000 | 40,000 | 40,000 | 40,000 | 45,000 |
| Salt, marine | | 1,000 | 1,000 | 1,000 | 1,000 | 1,000 |
| Sepiolite (meerschaum) | | 2 | 5 | 5 | 6 | 6 |
| SUDAN e/ 14/ | | | | | | |
| Cement, hydraulic | | 250,000 | 250,000 | 250,000 | 391,000 r/ | 380,000 |
| Chromium, chromite, mine output, gross weight 15/ | | 10,000 | 11,500 | 25,000 | 25,000 | 15,000 |
| Gold, mine output, Au content | kilograms | 1,000 | 1,600 | 3,000 | 3,700 | 4,500 |
| Petroleum: | | | | | | |
| Crude (including lease condensate) | thousand 42-gallon barrels | 110 | 360 | 730 | 730 | 1,000 |
| Refinery products | do. | 6,000 r/ | 6,200 r/ | 6,500 r/ | 6,600 r/ | 7,000 |
| Salt | | 75,000 | 75,000 | 75,000 | 75,000 | 50,000 |

e/ Estimated. r/ Revised.

1/ Includes data available through July 1997.

2/ In addition to the commodities listed, a variety of industrial minerals and construction materials (clays, gypsum, sand and gravel, and stone) are

produced; but information is inadequate to make reliable estimates of output.
3/ Plant closed in 1993.
4/ Table includes data available through July 15, 1997.
5/ Reported figure.
6/ In addition to the commodities listed, a variety of industrial minerals and construction materials (clays, gypsum, sand and gravel, and stone) are produced; but information is inadequate to make reliable estimates of output.
7/ Estimated data are rounded to three significant digits.
8/ Includes data available through May 21, 1997.
9/ In addition to commodities listed, modest quantities of unlisted varieties of crude construction materials (clay, sand and gravel, and other stone) may also be produced, but information in inadquate to make reliable estimates of output levels.
10/ Includes data available through June 30, 1997.
11/ In addition to commodities listed, the following are produced but information is inadequate to reliably estimate output: some gemstones (sapphire and tourmaline); limestone for cement and possibly agriculture; shale and/or clay for cement; and probably crude construction materials (e.g., clays for brick and tile, sand and gravel, stone) from small local operations. Beryllium (beryllium concentrate, estimated 10% BeO) production was last reported in 1985 at 27 tons. Tin smelter output was last reported in 1985 at 800 tons metal when the smelter was reported shut down.
12/ In addition to commodities listed, various crude construction materials (e.g., clays, sand and gravel, crushed and dimension stone) and limestone for lime manufacture and/or agriculture are presumably produced; also clay and/or shale are normally produced for cement manufacture, however, available information is inadequate to make reliable estimates of output.
13/ Estimated for cement manufacture only.
14/ In addition to the commodities listed, the following are presumably produced but available information is inadequate to reliably estimate output: clay and/or shale for cement manufacture (normally about 0.4 ton clay and/or shale per ton of finished cement); gypsum for cement manufacture (about 0.04 ton gypsum per ton of finished cement) and plaster; limestone for cement manufacture (normally at least 1.25 ton limestone per ton of finished cement), agriculture, lime manufacture, and construction aggregate and fill; and other locally used construction materials (clays, sand and gravel, stone, et al.). Also production of manganese ore (48% to 50% manganese) was reported for 1990 at 60,000 metric tons.
15/ Presumed to be ores and concentrates with an estimated average grade of about 48% chromic oxide.

## THE MINERAL INDUSTRY OF

# THE MIDDLE EAST

### By Bernadette Michalski, and Philip M. Mobbs

## Introduction

The 15 Middle East countries included in this report cover a land area of 6.17 million square kilometers, about two-thirds the size of the United States, and had a 1996 population of approximately 227 million people. World Bank estimates of gross national product (GNP) per capita in the Middle East, based on purchasing power parity data for 1995, ranged from a high of $24,000 in the United Arab Emirates to a low of $2,520 in Yemen. The GNP per capita in this energy-rich region averaged about $10,200. The mineral economy of the Middle East was dominated by the production of petroleum, supplemented by aluminum, cement, natural gas, nitrogen, phosphate rock, and potash output. The region as a whole accounted for nearly 30% of world crude petroleum production in 1996, and according to the 1997 International Petroleum Encyclopedia, was endowed with 66% of the world reserves of crude oil, including 26% in Saudi Arabia. A number of Middle Eastern countries continued to diversify their oil-dominant economies with growth in the nonfuel minerals sector.

Saudi Arabia was the world's leading producer of crude oil. Iran, Kuwait, and the United Arab Emirates also were significant suppliers of petroleum to the world market. *(See table 2.)* Utilizing the region's low-cost energy supply for energy intensive aluminum smelting, Bahrain and Dubai, United Arab Emirates accounted for over 3% of the world supply of primary aluminum. Israel and Jordan ranked as the world's sixth or seventh largest producer of phosphate rock and potash in 1996. Israel was also the world's second largest bromine producer. Turkey was the world's largest producer of boron minerals and magnesite, the second largest chromite producer and a major producer of barite, cement, feldspar, ferrochromium, glass, marble, perlite, pumice, steel and strontium. Litigation continued to delay development of the Ovacık gold mine. Zinc production was expected to increase as the new owners of Cinkur Kurşan Metal Sanyii A.Ş. refurbished the plant's zinc refinery. Also in Turkey, Etibank increased run-of-mine boron production by 34% during 1996.

Elsewhere in the Middle East, aluminum smelter expansion activities progressed on schedule in Bahrain and in Dubai, United Arab Emirates. Aluminum Bahrain (ALBA) anticipates the 76-cell extension of potline 3 to be operational by May 1997 enhancing smelting capacity by 36,500 t/yr for a total annual capacity approaching 0.5 million tons. Construction of 130,000 t/yr additional capacity at the Dubai Aluminum (DUBAL) smelter is scheduled for completion by September 1997 raising total capacity to nearly 375,000 t/yr.

The zinc industry in the Middle East is relatively undeveloped compared to the region's aluminum industry. A project involving indigenous zinc production could ease the region's traditional reliance on imports. The Arabian Shield Development Co. (ASDC) of the United States is about to begin commercial exploitation of the Al Masane polymetallic deposit in Saudi Arabia. The deposit is estimated by ASDC to total 7.2 million metric tons containing 5.3% zinc, 1.42% copper, 40 grams per metric ton (g/t) silver, and 1.19% g/t gold.

Oman and Qatar were evaluating new liquefied natural gas facilities. Iraq was floating the possibility of issuing petroleum production-sharing agreements with European petroleum companies, but remained unable to market petroleum or petroleum products because of the sustained embargo by the United Nations.

## TABLE 1
## MIDDLE EAST: PRODUCTION OF SELECTED MINERAL COMMODITIES 1/ 2/ 3/ IN 1996

(Thousand metric tons unless otherwise specified)

| Country | Aluminum e/ | Boron | Cement, hydraulic e/ | Chromite | Copper, mine Cu content | Gypsum e/ | Natural gas p/ 4/ Plant liquids (thousand 42-gallon barrels) | Natural gas p/ 4/ Dry (million cubic meters) |
|---|---|---|---|---|---|---|---|---|
| Bahrain | 461 5/ | -- | 193 5/ | -- | -- | -- | 3,650 | 6,950 |
| Cyprus | -- | -- | 1,000 | -- | 2 | 150 | -- | -- |
| Iran | 118 | 1 e/ | 16,500 | 129 e/ 6/ | 108 | 8,300 | 21,900 | 39,077 |
| Iraq | -- | -- | 18,000 | -- | -- | 450 7/ | 7,300 | 3,115 |
| Israel | -- | -- | 5,000 | -- | -- | 50 | -- | 18 |
| Jordan | -- | -- | 3,610 | -- | -- | 190 | -- | (8/) |
| Kuwait | -- | -- | 2,000 | -- | -- | -- | 31,025 | 9,400 |
| Lebanon | -- | -- | 4,000 | -- | -- | 3 | -- | -- |
| Oman | -- | -- | 1,260 | 15 | -- | -- | 3,650 | 3,176 |
| Qatar | -- | -- | 690 5/ | -- | -- | -- | 18,250 | 13,592 |
| Saudi Arabia | -- | -- | 16,437 5/ |  | 1 e/ | 363 5/ | 254,405 | 41,343 |
| Syria | -- | -- | 5,000 | -- | -- | 325 5/ | 2,920 | 3,000 e/ |
| Turkey | 60 | 2,379 | 35,214 5/ | 1,668 | 58 e/ | 600 | -- | 204 |
| United Arab Emirates | 251 | -- | 6,000 | 56 | -- | 90 | 58,400 | 40,000 e/ |
| Yemen | -- | -- | 1,100 5/ | -- | -- | 80 | -- | -- |
| Total, Middle East 9/ | 890 | 2,380 | 116,004 | 1,868 | 168 | 10,601 | 401,500 | 159,876 |
| Total, world | 20,700 | 2,980 | 1,484,564 | 12,246 | 10,992 | 99,716 | 2,037,430 | 2,320,847 |
| Share of world total | 4% | 80% | 8% | 15% | 2% | 11% | 20% | 7% |
| United States | 3,577 5/ | 1,150 | 80,818 5/ 10/ | -- | 1,918 | 17,500 5/ 11/ | 667,950 | 538,586 |

| Country | Nitrogen N in ammonia e/ | Petroleum, crude (thousand 42-gallon barrels) p/ 4/ 12/ | Phosphate rock e/ (gross weight) | Potash e/ $K_2O$ equivalent | Salt e/ | Steel, crude e/ | Sulfur e/ |
|---|---|---|---|---|---|---|---|
| Bahrain | 358 | 14,124 | -- | -- | -- | -- | 6 |
| Cyprus | -- | -- | -- | -- | -- | -- | -- |
| Iran | 700 | 1,345,390 | -- | -- | 450 | 5,415 | 890 |
| Iraq | 500 | 211,335 | 1,000 13/ | -- | 250 | 300 | 475 |
| Israel | 41 14/ | 36 | 3,800 13/ | 1,325 | 800 | 200 | 60 |
| Jordan | -- | -- | 5,350 | 1,080 | 25 | 30 | -- |
| Kuwait | 325 | 752,630 | -- | -- | 100 5/ | -- | 576 |
| Lebanon | -- | -- | -- | -- | 4 | -- | -- |
| Oman | -- | 322,295 | -- | -- | -- | -- | 35 |
| Qatar | 635 | 186,150 | -- | -- | -- | 626 5/ | 62 |
| Saudi Arabia | 1,300 | 2,999,570 | -- | -- | -- | 2,683 5/ | 2,200 |
| Syria | 68 | 220,460 | 2,000 | -- | 112 5/ | 70 | 10 |
| Turkey | 519 | 25 | -- | -- | 1,400 | 13,382 5/ | 160 |
| United Arab Emirates | 350 | 831,470 | -- | -- | -- | -- | 259 |
| Yemen | -- | 129,200 | -- | -- | 110 | -- | -- |
| Total, Middle East 9/ | 4,796 | 7,012,685 | 12,150 | 2,405 | 3,251 | 22,706 | 4,733 |
| Total, world | 97,466 | 23,379,710 | 132,750 | 23,895 | 192,272 | 758,070 | 52,201 |
| Share of world total | 5% | 30% | 9% | 10% | 2% | 3% | 9% |
| United States | 14,600 5/ 15/ | 2,359,725 | 45,400 | 1,390 5/ | 42,277 5/ 10/ | 18,220 5/ | 11,796 |

e/ Estimated. p/ Preliminary.

1/ Table prepared by Glenn J. Wallace.

2/ Table includes data available through Mar. 31, 1998.

3/ Data may be different from that appearing in individual country production tables owing to availability of more current data.

4/ Source: International Energy Annual 1996, Feb. 1998.

5/ Reported figure.

6/ Concentrate.

7/ For cement production only. Information is insufficient to formulate reliable estimates for output for other uses (plaster, mortar, etc.).

8/ Less than 1/2 unit.

9/ May not add to totals shown because of independent rounding.

10/ Includes Puerto Rico data.

11/ Excludes byproduct gypsum.

12/ Includes lease condensate.

13/ Beneficiated.

14/ May include nitrogen content of urea.

15/ Synthetic anhydrous ammonia; excludes coke oven byproduct ammonia.

Source: U.S. Geological Survey.

# THE MINERAL INDUSTRY OF

# BAHRAIN

### By Bernadette Michalski

The mineral industry of Bahrain supplied more than 90% of Government revenues and export earnings in 1996. Crude oil from Bahrain's Awali Field was supplemented by shared production from the Abu Saafa offshore field that straddles the territorial waters of Bahrain and Saudi Arabia. In early 1996, Saudi Arabia assigned to Bahrain the total production from the Abu Saafa Field commencing April 1, 1996. The availability of natural gas, principally from the Khuff reservoir, for electric power generation has fostered the Nation's aluminum smelting and fabrication industries for a quarter of a century. Feedstock for the aluminum plant was imported with about 75% of the alumina supply obtained from Alcoa of Australia. Aluminium Bahrain's (ALBA) smelter at 460,000 metric tons per year (t/yr) capacity is the largest in the Middle East.

Production of the nation's mineral commodities for the most part has stabilized. Output of crude petroleum has been maintained at nearly 15 million barrels per year sustained by natural gas injection; it is expected to continue near this level throughout this decade. Unless additional reserves are identified, domestic onshore production is expected to cease by 2000.

ALBA has operated at near-capacity levels throughout the decade. However, production targets were temporarily reduced in 1993 and part of 1994 to support world aluminum prices. *(See table 1.)* Billet and rolling slab represent about 40% of production.

Aluminum accounted for more than one-fourth of total exports by value in 1996. Nearly two-thirds of the exported aluminum was delivered to member countries of the Gulf Cooperation Council (GCC).

Combined exports of methanol and ammonia were 870,500 metric tons (t) in 1996. All production was exported to markets principally in Asia and Western Europe. A 1,700-metric-ton-per-day (t/d)-capacity urea plant is scheduled to commence production by yearend 1997. Therefore, ammonia exports are likely to fall substantially in 1998 in favor of providing feedstock to the urea plant.

Bahrain's oil and natural gas industry was wholly Government-owned, and most other mineral commodity ventures were Government-controlled. However, private domestic and foreign investment was being encouraged by allowing fully foreign-owned companies to register in Bahrain. The Bahrain Aluminium Extrusion Co. (Balexco), formerly wholly owned by the Government, has been totally privatized. It was the first state-owned company offered for privatization.

A 36,500 t/yr expansion program was underway, elevating the ALBA aluminum smelter's capacity to 496,500 t. The expansion involved extending the third potline by 76 cells and is scheduled for completion in May 1997. Additional production would be absorbed by increasing demand from downstream industries in Bahrain and the GCC. This includes Balexco where expansion to 21,000 t/yr was effected with the commissioning of a third extrusion line in 1996. The Bahrain Alloys Manufacturing Co. uses molten aluminum from the Alba smelter to manufacture foundry alloys for the automotive and aerospace industries with markets principally in Europe.

The Gulf Aluminum Rolling Mill Co., Bahrain's coil and sheet producer for the construction and foil industry, tripled capacity to 120,000 t/yr in 1996. Raytheon Co. of the United States was the consultant for the expansion engineering work.

The bulk of Bahrain's natural gas production is extracted from the Khuff Zone. Only 23% of the natural gas supply is derived from associated gas in the Awali Field. More than one-fourth of total natural gas production was injected for enhanced recovery operations necessary to maintain petroleum production at the Awali Field. The remaining output was utilized in the production of electric power and as a petrochemical feedstock.

Gulf Petrochemical Industries Co. (GPIC), a joint venture between Bahrain and Kuwait, operated an ammonia and methanol plant at Sitra producing more than 400,000 t/yr of each commodity in recent years. The petrochemical use of natural gas was approximately 1.2 billion cubic meters in 1996. GPIC has awarded a construction contract for its 1,700 t/d urea plant, which will consume 80% of GPIC's ammonia output. Total cost of the project is estimated at just under $140 million.

The 250,000 barrels-per-day (bbl/d) capacity refinery at Sitra has consistently operated at or above capacity. About 84% of the refinery's throughput was delivered by pipeline from Saudi Arabia and the remainder from the Awali Field. The domestic demand for petroleum products exceeded 10,000 bbl/d, with the remaining output destined for the export market.

Proven crude oil reserves were estimated at 60 million barrels and natural gas reserves were estimated at about 170 billion cubic meters.

The island Nation's basic infrastructure is in place, including a network of petroleum pipelines and storage facilities to accommodate Sitra refinery receipts from the Awali Field and the Abu Saafa Field shared with Saudi Arabia. In addition, 16 product pipelines extend for 5 kilometers (km) from the Sitra refinery storage facilities to a deepwater terminal for export. Natural gas pipelines servicing Bahrain's power generation and industry complexes totaled 32 km in length.

The Directorate of Electricity operates plants at Manama, Sitra, and Rifaa. Their combined capacity is 992 megawatts (MW). An additional 200 MW from Alba's 800-MW powerplant is available. Bahrain Petroleum Co. also produces its own electricity from a 60-MW plant.

## Major Sources of Information

Ministry of Industry and Development
Manama, Bahrain
Bahrain National Oil Co.
P.O. Box 25504
Awali, Bahrain
Telephone: (973) 754 666
Fax: (973) 753 203
Bahrain Petroleum Co.
Awali, Bahrain
Telephone: (973) 754 444
Fax: (973) 752 924
Bahrain National Gas Co.
P.O. Box 29099
Rifaa, Bahrain
Telephone: (973) 756 222
Fax: (973) 756 991
Caltex Bahrain
P.O. Box 25125
Awali, Bahrain
Telephone: (973) 753 134
Fax: (973) 753 122
Harken Bahrain Oil
P.O. Box 11715
Manama, Bahrain
Telephone: (973) 531 735
Fax: (973) 536 592
Aluminium Bahrain (ALBA)
P.O. Box 570
Manama, Bahrain
Telephone: (973) 661 751

### TABLE 1
### BAHRAIN: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

| Commodity | | 1992 | 1993 | 1994 | 1995 | 1996 e/ |
|---|---|---|---|---|---|---|
| Aluminum, smelter output, primary metal | | 292,400 | 447,514 | 447,000 | 450,709 | 461,245 2/ |
| Cement | | 220,000 | 225,000 | 225,000 | 196,568 r/ | 193,000 |
| Gas, natural: | | | | | | |
| Gross | million cubic meters | 9,415 r/ | 9,798 r/ | 9,946 | 12,538 r/ | 12,700 |
| Dry | do. | 4,015 | 6,926 | 7,091 | 7,205 r/ | 6,950 |
| Methanol | | 413,691 | 428,458 | 419,322 | 427,350 | 384,558 2/ |
| Natural gas plant liquids: | | | | | | |
| Propane | thousand 42-gallon barrels | 1,608 | 1,471 | 1,455 r/ | 1,375 r/ | 1,087 2/ |
| Butane | do. | 1,236 | 1,116 | 1,190 r/ | 1,163 | 1,272 2/ |
| Naphtha | do. | 1,848 | 1,800 | 1,863 | 1,848 | 1,784 2/ |
| Nitrogen: N content of ammonia | | 332,800 | 348,375 | 337,506 | 357,504 | 358,000 |
| Petroleum: | | | | | | |
| Crude | thousand 42-gallon barrels | 15,123 | 14,875 | 14,695 | 14,468 | 14,124 |
| Refinery products: | | | | | | |
| Gasoline | do. | 8,500 r/ | 9,228 r/ | 7,704 | 7,766 | 8,134 |
| Jet fuel | do. | 7,500 | 4,410 | 7,106 | 6,219 | 6,200 |
| Kerosene | do. | 10,500 | 12,282 | 10,409 | 11,327 | 11,300 |
| Distillate fuel oil | do. | 28,000 | 29,360 | 28,852 | 31,027 | 31,050 |
| Residual fuel oil | do. | 23,500 | 22,188 | 20,896 | 20,807 | 20,800 |
| Other | do. | 16,300 | 12,190 | 13,630 | 14,728 r/ | 14,730 |
| Total | do. | 94,300 r/ | 89,658 r/ | 88,597 | 91,874 r/ | 92,214 |
| Sulfur | | 56,600 r/ | 53,700 r/ | 52,312 r/ | 55,390 r/ | 6,520 |

e/ Estimated. r/ Revised.

1/ Table includes data available through May 1, 1997.

2/ Reported figure.

### THE MINERAL INDUSTRY OF

# CYPRUS

### By Bernadette Michalski

In recent years, following the depletion of economic zones of their well known copper deposits, mineral production was mainly by local companies working small deposits. Aggregates, cement, and dimension stone production supplied the domestic construction industry and accounted for the bulk of mineral exports in 1996. The value of mining and quarrying products was approximately $100 million,[1] nearly one-half of which was attributed to the hydraulic cement industry. *(See table 1.)* Mineral imports exceeded $505 million accounting for 14% of total exports. Fuels and related materials accounted for slightly more than one-half of mineral imports, while metals accounted for one-third of mineral imports. The principal sources of mineral imports were Europe and central Eurasia. Exports of mineral commodities were valued at $34 million accounting for more than 6% of total exports. Industrial mineral exports accounted for $21 million, the bulk of which was destined for the Middle East. Economic growth in 1996 was 3.5%.

The Mines Service administered mineral operations under the Mines and Quarries (Regulation) Law, Chapter 270, 1959; the Mines and Quarries Regulations, 1958-79; the Petroleum (Production) Law, 1974; and the Cyprus Standard and Control of Quality Law, 1975. Mining operations in Cyprus have been owned and operated privately under leases and licenses issued by the Mines Service since 1958. Royalties on extracted mineral commodities ranged from 1% to 5%.

Offshore companies pay a flat corporate tax rate of 4.25% and are not subject to any exchange control restrictions if they trade in Cyprus and do not borrow from a Cypriot Bank.

The Ministry of Agriculture, Natural Resources, and Environment was developing an integrated legislative framework for the protection of the environment as well as adopting an effective mechanism for the coordination of environmental policy issues.

Most of the country's traditional mineral enterprises were either shut down or were operating at a small fraction of past production levels; however, the resource base of commodities, such as asbestos, bentonite, celestite, chromite, copper, iron oxide pigments, pyrite, and salt was still significant. Producers of these commodities could possibly resume operations or increase production under more favorable economic conditions.

Engineering, equipment supply, and construction planning services for a solvent extraction and electrowinning project at the Skouriotissa copper mine were completed in 1996. The plant is designed to produce 8,000 metric tons per year (t/yr) of copper cathode. This plant will replace a cementation operation which was processing copper from tailings produced by an open pit mine which ceased operation more than two decades past. Copper ore reserves at Skouriotissa grading 0.6% copper are reported to be 15 million metric tons. The Hellenic Mining Co. holds 44% equity and 43.7% equity is held by Oxiana Resources of Australia.

In an effort to transform Cyprus into a trading hub of the eastern Mediterranean, the government has inaugurated in October 1996 a $40 million mega-merchandising complex near Nicosia called the International Merchandising Center. The center is a duty free shop for traders who use the nation as a major offshore base for materials destined for the Middle East and southern Europe.

**Major Source of Information**

Ministry of Agriculture, Natural Resources, and Environment
Nicosia, Cyprus
Telephone 357-2-309283
Fax: 357-2-316872
Ministry of Commerce, Industry, and Tourism
6 A Araouzos Street
Nicosia, Cyprus
Telephone: 357-2-308041
Fax: 357-2-375120

---

[1] Where necessary, values have been converted from Cypriot pounds (C£) to U.S. dollars at the rate of C£0.46=US$1.00. Unless specifically stated, all data in this chapter are for the southern Greek-administered area because data related to the Turkish Cypriot area are sparse or unavailable.

## TABLE 1
## CYPRUS: PRODUCTION OF MINERAL COMMODITIES 1/ 2/

(Thousand metric tons unless otherwise specified)

| Commodity | | 1992 | 1993 | 1994 | 1995 | 1996 e/ |
|---|---|---|---|---|---|---|
| METALS | | | | | | |
| Copper, cement: 3/ | | | | | | |
| Gross weight | metric tons | 473 | 278 | -- | -- | NA |
| Cu content | do. | 172 | 103 | -- | -- | 1,499 |
| INDUSTRIAL MINERALS | | | | | | |
| Cement, hydraulic | | 1,131 | 1,089 | 1,044 | 1,021 | 1,000 |
| Clays, crude: | | | | | | |
| Bentonite | metric tons | 58,800 | 60,000 | 48,975 | 49,487 | 70,660 |
| Other: | | | | | | |
| For brick and tile manufacture | | 463 | 450 | 475 | 407 | 400 |
| For cement manufacture e/ | | 346 | 350 | 375 | 350 | 350 |
| Total | | 809 | 800 | 850 | 757 e/ | 750 |
| Gypsum: | | | | | | |
| Crude | metric tons | 35,470 | 90,000 | 180,000 | 133,208 | 150,468 |
| Calcined | do. | 6,150 | 3,000 | 4,000 | 4,000 e/ | 4,000 |
| Lime, hydrated | do. | 5,540 | 6,100 | 5,525 | 5,530 | 5,500 |
| Stone, sand, and gravel: | | | | | | |
| Limestone, crushed (Havara) | | 2,800 | 3,000 | 3,000 e/ | 3,200 | 3,000 |
| Marble | | 58 | 50 | 50 e/ | 50 e/ | 50 |
| Marl, for cement production | | 1,400 e/ | 1,500 4/ | 1,600 | 2,000 | 1,600 |
| Sand and gravel 5/ | | 5,750 | 6,000 | 6,000 e/ | 6,000 e/ | 6,000 |
| Building stone | | 250 e/ | 100 | 1,436 | 974 | 800 |
| Umber | metric tons | 5,000 | 6,000 e/ | 9,000 e/ | 5,415 | 4,604 |
| MINERAL FUELS AND RELATED MATERIALS | | | | | | |
| Petroleum refinery products: | | | | | | |
| Liquefied petroleum gas | thousand 42-gallon barrels | 300 | 308 | 350 r/ | 350 r/ e/ | 350 |
| Gasoline | do. | 1,100 | 799 | 900 r/ | 1,000 r/ e/ | 1,000 |
| Kerosene and jet fuel | do. | 300 | 346 | 400 r/ | 400 r/ e/ | 400 |
| Distillate fuel oil | do. | 2,200 | 1,886 | 2,450 r/ | 2,500 r/ e/ | 2,500 |
| Residual fuel oil | do. | 1,500 | 2,000 | 2,500 r/ | 2,500 r/ e/ | 2,550 |
| Asphalt | do. | 200 | 208 | 200 | 200 e/ | 200 |
| Total | do. | 5,600 | 5,547 | 6,800 r/ | 6,950 r/ e/ | 7,000 |

e/ Estimated. r/ Revised.

1/ Table includes data available through May 15, 1997.

2/ Mineral production data from the northern Turkish-occupied section of the country are not included in this table, as available information is inadequate to make reliable estimates of output levels.

3/ Hellenic Mining Co. ceased copper recovery operations from the Skouriotissa Mine tailings in 1993.

4/ Reported figure.

5/ Includes crushed aggregate.

# THE MINERAL INDUSTRY OF

# IRAN

## By William S. Kirk

Iran continued to rebuild its economy and to move toward independence from oil revenues. The value of industrial output reached US$15.4 billion per year with the mining and metals sectors accounting for 24% (Mining Journal, 1997).

The current Five-Year Plan (1995-99) pursues two main development strategies — industries based on natural resources, in particular natural gas, mines, and metal products, and export-oriented industries. The highest priority is given to the development of mineral resources and the production of intermediate and final metal products, particularly steel, aluminum, copper, and zinc.

The overall management of the minerals sector was under the auspices of the Ministry of Mines and Metals. The Ministry's authority covers all mining, smelting, and refining industries except oil and gas, which were under the Ministry of Petroleum.

The Government continued to emphasize privatization of the mining industry. This included mostly small mines and excluded large operations such as the Sar Cheshmeh copper complex; the Chadormalu, the Choghart, the Gol-e Gohar, and the Sangan iron deposits; and the Angouran lead-zinc mine, although many of the operations, which were for sale, did not attract buyers because they had deteriorated as the result of ineffective management and lack of technical expertise in the 1980's.

During the year, 42 mineral commodities, excluding sand and gravel, were produced from 1,785 mines with a crude ore output of 74 million metric tons (Mt). Iran's exports of metals and minerals were valued at US$645 million.

The first phase of construction and installation work on the Al-Mahdi aluminum plant at Port Bandar Abbas in the Strait of Hormuz was completed. The US$1.6 billion project was expected to come onstream with a capacity of 110,000 metric tons per year (t/yr) in 1997. The final capacity of 220,000 t/yr was expected to be reached in 2000. Development of the 22 Mt bauxite deposit at Jajarm and the construction of a 100,000-t/yr-capacity alumina refinery plant were begun. Iran also plans to produce alumina from the nepheline syenite deposits at Kaleybar and Sarab in eastern Azerbaijan Province.

Iran's first ferrochromium production plant began operating in Bandar Abbas. The plant, with four furnaces, is expected to have a production capacity of 60,000 t/yr (Ettala'at, 1996).

National Iranian Copper Industries Co. produced about 14 Mt of crude copper ore at the Sarcheshmeh copper complex west of Rafsanjan in Kerman Province. From that crude ore, 367,000 metric tons (t) of copper concentrate and, in turn, 126,000 t of anode and 93,000 t of cathode was produced. An expansion project at the complex was expected to add heap leaching facilities with a solvent extraction-electrowinning plant, which, in turn, was expected to add 14,000 t/yr of capacity. To improve the production of the Songoon and Mazraeh copper mine and concentrator at Ahar in east Azerbaijan Province, a US$350 million barter-trade agreement was signed with China. Iran expects to increase annual copper production to 250,000 t/yr by the end of the current Five-Year Plan in 1999.

The Mouteh gold mine and smelter produced 255 kilograms of gold. Two new mines are being developed at Zarkouh, south of Damghan, and at Zar-e Shouran, southwest of Zanjan.

Steel production by the National Iranian Steel Co. (Nisco), the Isfahan blast furnace, the direct reduction plants of Mobarakeh, and the Khousistan steel complex at Ahwaz totaled 5.7 Mt, up from 4.9 Mt in 1995. Nisco became the world's 30th largest steelmaker in 1996. The increased steel production prompted increased iron ore production in an effort to achieve Iran's goal to become self-sufficient in iron ore.

Iran has four main iron ore deposits that are currently being mined or are under development—Chadormalu, Choghart, Gole Gohar, and Sangan. The Chadormalu Mine and concentrator, 125 kilometers (km) northeast of Yazd, is being developed and is expected to be in operation by the end of 1997. The US$900 million project is projected to produce 5.1 million metric tons per year (Mt/yr) of ore per year. The Choghart iron ore mine at Bafq near Yazd supplies about 5.2 Mt/yr year to the Isfahan steelworks. The addition of a US$115 million ore processing plant is underway. The Gol-e Gohar Mine, 55 km southwest of Sirjan, provides 2.5 Mt/yr of iron ore concentrate to the Mobarakeh steel complex. Its capacity is expected to rise to 5 Mt/yr of concentrate by 1999. The Sangan Mine, about 250 km southeast of Mashad close to the border with Afghanistan, is under development and is expected to have an initial capacity of 3.4 Mt/yr of concentrate (Metal Bulletin, 1996b).

The Nation's lead and zinc production was derived from six mines, of which three are the principal producers—the largest, Angouran, southwest of Zanjan; Irankuh, on the outskirts of Isfahan; and Kushk-Bafq, near Yazd. The country planned to invest US$300 million to increase its zinc metal production. It was constructing a smelter in Bafgh, 580 km southeast of Tehran, which was expected to produce 30,000 t of zinc in 1997, eventually reaching 50,000 t/yr. As part of the Government's investment, a 7,000-t/yr smelter in the northwestern city of Zanjan, a 7,000-t/yr smelter in Bandar Abbas on the Arabian Gulf, and three smaller units were also nearing completion. Exploratory work at Mehdiabad in Yazd Province has been completed (Metal Bulletin, 1996a).

Iran is a major producer of industrial minerals. It is the world's third largest producer of gypsum, is one of the leading producers of cement in the Middle East, and has 27 phosphate mines. New mining projects are underway for phosphate, magesite, celestite, asbestos, and titano-magnetioxide (Global Cement Report, 1996).

Although production at Nisco's coal mines increased to 1.2 Mt, the steel mill at Isfahan had to import about 500,000 t of coking coal. Development of the major coal mining project at Tabas in the remote area of Khorassan was begun.

Published reserves data were inadequate to provide a meaningful inventory of Iran's mineral resources. The Oil Ministry has reported the country's total oil reserves to be 90,000 million barrels. The Geological Survey of Iran was actively involved in a number of exploration programs for base and precious metals.

Efforts were being made to rehabilitate or improve transportation facilities throughout the country. The construction of the Trans-Asian railway (298 km long, connecting Mashad in northeast Iran to Tajan in Turkmenistan) was completed and became operational. It was to provide access for Middle Eastern countries to international waters south of Iran.

Iran has a number of comparative advantages in terms of steel production. Low labor costs, cheap energy from natural gas, sizable if low-grade iron ore deposits, and domestic supplies of coking coal and limestone should support the development of a significant steel industry.

The Government's main challenge was the successful implementation of its economic restructuring phase. Expansion of the mineral industry can be expected as trends favoring privatization and foreign investment continue.

### References Cited

Ettala'at 1996, Nationwide survey of mines, production: Ettala'at, May 21. (Available from Foreign Broadcast Information Service, Washington, DC, as an electronic subscription; FBIS@pub.com.)

Global Cement Report, 1996, Iran: The Global Cement Report, October, p. 138.

Metal Bulletin, 1996a, Iran to boost production: Metal Bulletin, no. 8141, p. 3.

———1996b, Posco moves closer to world No. 1 spot: Metal Bulletin, no. 8156, p. 23.

Mining Journal, 1997, Mining annual review—1997: Mining Journal, p. 163-164.

### Major Sources of Information

Geological Survey of Iran
P.O. Box 13185-1491
Tehran, Iran
Ministry of Mines and Metals
P.O. Box 1416
14155 Tehran, Iran
Telephone: (98) 21 836050
Ministry of Petroleum
Taleghani St.
Tehran, Iran
Telephone: (98) 21 661120
Facsimile: (98) 21 666293

## TABLE 1
## IRAN: PRODUCTION OF MINERAL COMMODITIES 1/ 2/

(Metric tons unless otherwise specified)

| Commodity | | 1992 | 1993 | 1994 | 1995 | 1996 e/ |
|---|---|---|---|---|---|---|
| METALS | | | | | | |
| Aluminum: | | | | | | |
| Bauxite, gross weight e/ | | 100,000 | 100,000 | 100,000 | 100,000 | 100,000 |
| Metal, primary ingot | | 117,230 | 109,190 | 116,000 | 118,000 e/ | 118,000 |
| Arsenic, orpiment and realgar, concentrates e/ | | 492 3/ | 500 | 500 | 500 | 500 |
| Chromium, chromite, mine output: Concentrate (48% to 50% $Cr_2O_3$): | | | | | | |
| Gross weight | | 130,265 | 114,780 | 129,000 e/ | 129,000 r/ e/ | 129,000 |
| $Cr_2O_3$ content e/ | | 64,000 | 64,000 | 64,000 | 64,000 | 64,000 |
| Copper: | | | | | | |
| Mine output: | | | | | | |
| Ore mined (1% to 1.2% Cu): | | | | | | |
| Gross weight | thousand tons | 9,230 | 10,800 | 12,400 | 13,150 | 13,000 |
| Cu content | | 108,000 | 86,600 | 100,040 | 120,000 e/ | 120,000 |
| Concentrate (29% to 35% Cu): | | | | | | |
| Gross weight e/ | | 304,000 3/ | 290,000 | 360,000 | 325,000 | 320,000 |
| Cu content | | 105,400 | 86,600 | 117,900 | 102,200 r/ | 107,600 |
| Metal: | | | | | | |
| Smelter output, blister/anode | | 86,400 | 85,000 | 123,800 | 81,300 e/ | 82,000 |
| Refined output, cathode | | 101,800 | 84,900 | 90,200 r/ | 90,400 r/ | 99,100 |
| Gold, mine output, Au content | kilograms | 500 e/ | 417 | 723 | 650 e/ | 650 |
| Iron and steel: | | | | | | |
| Ore and concentrate: | | | | | | |
| Gross weight | thousand tons | 5,647 | 9,870 | 8,690 | 9,080 e/ | 9,000 |
| Fe content e/ | do. | 3,000 | 4,800 | 4,300 | 4,500 | 4,500 |
| Metal: | | | | | | |
| Pig iron | do. | 2,053 | 1,961 | 1,883 | 1,532 | 1,867 3/ |
| Direct-reduced iron | do. | 709 | 1,631 | 2,861 | 3,301 | 3,778 3/ |
| Ferroalloys, ferrochromium e/ | do. | -- | -- | 5 | 115 r/ 3/ | 150 3/ |
| Steel, crude, ingots and casting | do. | 3,081 | 3,672 | 4,498 | 4,696 | 5,415 3/ |
| Lead: | | | | | | |
| Mine output, concentrate (56% to 60% Pb): | | | | | | |
| Gross weight | | 20,000 | 22,000 | 30,000 | 30,000 e/ | 30,000 |
| Pb content | | 12,400 | 14,700 r/ | 18,300 | 15,900 r/ | 15,700 |
| Refinery output, includes secondary | | 42,000 | 52,000 | 51,000 | 45,000 r/ | 47,000 |
| Manganese, mine output, (30% to 35% Mn): | | | | | | |
| Gross weight | | 38,475 | 75,978 | 75,000 e/ | 75,000 r/ e/ | 75,000 |
| Mn content e/ | | 12,000 | 25,000 | 25,000 | 25,000 | 25,000 |
| Molybdenum, mine output, concentrate (56% Mo): e/ | | | | | | |
| Gross weight | | 1,510 3/ | 1,200 | 1,200 | 1,600 | 1,600 |
| Mo content | | 847 3/ | 700 | 670 | 560 | 560 |
| Silver, mine output, Ag content e/ | | 50 | 60 | 60 | 60 | 60 |
| Zinc, mine output, concentrate (50 to 55% Zn): | | | | | | |
| Gross weight e/ | | 132,000 r/ | 154,000 r/ | 146,000 | 290,000 r/ | 152,000 |
| Zn content | | 66,000 r/ | 77,000 r/ | 73,000 r/ | 145,000 r/ | 76,000 |
| INDUSTRIAL MINERALS | | | | | | |
| Asbestos: | | | | | | |
| Concentrate, (3% to 8% marketable fiber) | | 86,200 | 80,000 e/ | 80,000 | 65,000 e/ | 65,000 |
| Marketable fiber e/ | | 4,300 | 4,500 | 4,500 | 4,500 r/ | 4,500 |
| Barite | | 181,174 | 226,377 | 139,000 r/ e/ | 150,000 r/ | 150,000 |
| Boron, borax e/ | | 420 3/ | 500 | 500 | 500 | 500 |
| Cement, hydraulic e/ | thousand tons | 15,200 | 16,000 | 16,000 | 16,300 | 16,500 |
| Clays: | | | | | | |
| Bauxite and refractory clays e/ | | 215,000 3/ | 220,000 | 220,000 | 220,000 | 220,000 |
| Bentonite | | 62,000 | 53,667 | 70,000 | 32,000 e/ | 32,000 |
| Other: | | | | | | |
| Industrial clays e/ | | 120,000 3/ | 250,000 | 300,000 | 250,000 | 250,000 |
| Kaolin | | 264,083 | 254,413 | 250,000 e/ | 250,000 e/ | 250,000 |
| Total | | 384,083 | 504,413 | 550,000 e/ | 500,000 e/ | 500,000 |
| Diatomite e/ | | 100 | 85 3/ | 90 | 90 | 90 |
| Feldspar | | 52,120 | 76,873 | 75,000 r/ e/ | 75,000 r/ e/ | 6,000 |

See footnotes at end of table.

## TABLE 1--Continued
## IRAN: PRODUCTION OF MINERAL COMMODITIES 1/ 2/

(Metric tons unless otherwise specified)

| Commodity | | 1992 | 1993 | 1994 | 1995 | 1996 e/ |
|---|---|---|---|---|---|---|
| INDUSTRIAL MINERALS--Continued | | | | | | |
| Fluorspar, fluorite e/ | | 9,180 3/ | 10,000 | 10,000 | 10,000 | 10,000 |
| Gemstones, turquoise e/ | kilograms | 1,000 | 5,000 | 5,000 | 5,000 | 5,000 |
| Gypsum | thousand tons | 8,253 | 7,799 | 8,430 e/ | 8,230 | 8,300 |
| Industrial or glass sand (quartzite and silica) | | 756,000 | 932,000 | 950,000 e/ | 1,000,000 e/ | 1,000,000 |
| Lime e/ | thousand tons | 650 | 650 | 650 | 650 | 650 |
| Magnesium compounds e/ | | 36,165 3/ | 49,424 3/ | 45,000 | 55,000 | 55,000 |
| Mica e/ | | 7,850 3/ | 1,224 3/ | 3,000 | 3,000 | 3,000 |
| Nitrogen: N content of ammonia | | 664,000 | 722,500 | 696,200 | 715,400 | 700,000 |
| Perlite e/ | | 5,000 3/ | 6,000 | 6,000 | 6,000 | 6,000 |
| Pigments, mineral, natural iron oxide e/ | | 2,310 3/ | 2,500 | 2,500 | 2,500 | 2,500 |
| Pumice and related volcanic materials | | 330,000 | 185,000 | 200,000 e/ | 200,000 e/ | 200,000 |
| Salt | | 1,018,000 | 988,700 | 1,050,000 | 936,000 | 450,000 |
| Sodium compound, caustic soda e/ | | 15,000 | 15,000 | 15,000 | 15,000 | 15,000 |
| Stone: | | | | | | |
| Construction and building, crushed, n.e.s. e/ | thousand tons | 4,340 3/ | 4,500 | 4,800 | 4,800 | 4,800 |
| Dimension and decorative: e/ | | | | | | |
| Granite | do. | 24 3/ | 30 | 20 | 20 | 20 |
| Marble: | | | | | | |
| Blocks | do. | 3,970 3/ | 3,200 | 4,500 | 4,500 | 4,500 |
| Crushed | do. | 786 3/ | 400 | 450 | 450 | 450 |
| Slabs | do. | 19 3/ | 20 | 50 | 50 | 50 |
| Travertine: | | | | | | |
| Blocks | do. | 341 3/ | 300 | 500 | 500 | 500 |
| Crushed and slabs | do. | 93 3/ | 60 | 70 | 70 | 70 |
| Total | do. | 5,233 3/ | 4,010 | 5,590 | 5,590 | 5,590 |
| Dolomite | do. | 227 | 173 | 200 e/ | 243 | 200 |
| Limestone | do. | 23,800 | 26,000 | 28,000 e/ | 28,000 e/ | 28,000 |
| Strontium, celesite e/ | | 13,100 3/ | 20,000 | 20,000 | 20,000 | 20,000 |
| Sulfates, natural: | | | | | | |
| Aluminum potassium sulfate (alum) e/ | | 12,000 | 12,000 | 12,000 | 12,000 | 12,000 |
| Sodium sulfate | | 237,000 | 280,000 | 280,000 r/ e/ | 280,000 r/ e/ | 280,000 |
| Sulfur: e/ | | | | | | |
| Byproduct of petroleum and natural gas | | 700,000 | 750,000 | 830,000 | 840,000 | 840,000 |
| Byproduct of metallurgical processing, S content of acid | | 50,000 | 50,000 | 50,000 | 50,000 | 50,000 |
| Total | | 750,000 | 800,000 | 880,000 3/ | 890,000 | 890,000 |
| Talc | | 23,707 | 18,000 | 18,000 e/ | 20,000 e/ | 20,000 |
| MINERAL FUELS AND RELATED MATERIALS | | | | | | |
| Coal | thousand tons | 1,508 | 1,665 | 1,720 | 1,500 e/ | 1,500 |
| Coke e/ | do. | 506 3/ | 600 | 700 | 700 | 700 |
| Gas, natural: | | | | | | |
| Gross | million cubic meters | 58,200 | 60,000 | 61,000 | 61,000 e/ | 61,000 |
| Dry | do. | 25,000 | 27,100 | 28,200 | 28,200 e/ | 28,200 |
| Natural gas plant liquids | thousand 42-gallon barrels | 20,000 | 23,300 | 23,500 | 23,500 e/ | 23,500 |
| Petroleum: | | | | | | |
| Crude | do. | 1,256,900 | 1,332,000 | 1,325,000 | 1,329,700 | 1,329,700 |
| Refinery products: e/ | | | | | | |
| Liquefied petroleum gases | do. | 19,000 3/ | 20,000 | 23,000 r/ 3/ | 24,000 | 24,000 |
| Motor gasoline | do. | 50,400 3/ | 50,000 | 51,500 | 54,500 | 54,500 |
| Jet fuel | do. | 8,030 3/ | 8,000 | 9,200 r/ 3/ | 9,000 | 9,000 |
| Kerosene | do. | 30,700 3/ | 32,000 | 34,400 | 37,000 | 37,000 |
| Distillate fuel oil | do. | 101,000 3/ | 100,000 | 107,600 r/ 3/ | 117,000 | 117,000 |
| Residual fuel oil | do. | 96,700 3/ | 100,000 | 103,000 | 114,000 | 114,000 |
| Other | do. | 35,800 3/ | 40,000 | 35,800 r/ 3/ | 43,000 | 43,000 |
| Total | do. | 341,630 3/ | 350,000 | 364,500 r/ | 398,500 | 398,500 |

e/ Estimated. r/ Revised.

1/ Table includes data available through Dec. 1997.

2/ Data are for Iranian years ending Mar. 21 of that stated, except data for natural gas, plant liquids, and petroleum, which are for Gregorian calendar years.

3/ Reported figure.

## THE MINERAL INDUSTRY OF

# IRAQ

### By Larry Cunningham

Minerals, particularly petroleum, continued to dominate Iraq's economy in 1996 as they have for decades. Prior to Iraq's invasion of Kuwait in August 1990, which caused the United Nations (U. N.) to impose economic sanctions, Iraq was one of the world's top 10 oil producers. Iraq's crude oil reserves of more than 100 billion barrels (Gbbl) were the world's next largest after those of Saudi Arabia (Penn Well Publishing Co., 1996). Iraq was also an important regional producer of cement and sulfur, as well as phosphate and urea (nitrogen) for fertilizers.

Before 1990, the value of Iraq's exports were estimated to be about $15 billion per year, with oil accounting for about 90% of the total. By 1995, exports were valued at about $570 million with oil accounting for about 80% of the total. Following international sanctions, Iraq was only officially allowed to export to Jordan (Arab Petroleum Research Center, 1997).

Pending Iraq's full compliance with the U. N. resolutions, the trade embargo on everything except humanitarian needs (oil for food) remained a severe restriction on the country's mineral production, as well as the entire economy. Thus, the country's industrial production during 1996 was mostly limited to satisfying domestic consumption.

After nearly 6 years of strict international sanctions, Iraq reached an agreement on May 20, 1996, with the U. N. allowing limited oil exports for humanitarian needs. The U. N.-Iraqi agreement, under U. N. Resolution 986, permits Iraq to sell up to $2 billion worth of oil during a 6-month period. Exports under the agreement began in December. The volume of oil that can be sold under the agreement is dependent on the price of oil. If the price of oil goes up, then the volume of Iraqi exports will decrease, and if the price goes down, then the volume of exports will increase, which could contribute to a weakening of the world oil market. Iraq's sales strategy was to sign a large number of small contracts in hopes of renewing contacts with as many of its former customers as possible. During December, the U. N. approved 16 contracts signed by Iraq's State Oil Marketing Organization.

The structure of the mineral industry was not fully defined in available sources, but most mineral commodity production facilities were apparently owned by the Government. (*See table 1*).

Iron and steel facilities were located at Khor al Zubair, southwest of Basrah in southern Iraq. The facilities included two natural gas-based direct-reduced iron units for sponge iron production and four electric arc furnaces for steel production.

Cement plants in operation totaled about 12, of which 7 had a capacity of about 2 million metric tons per year or more. Most of the plants were spaced at intervals along the Euphrates River from Basrah to the Syrian border. Several plants were in the north near Mosul and Kirkuk.

Ammonia plants were situated at five locations—three near Basrah in the south, one at Baiji in the middle north on the Tigris River, and one at Al Qaim in the west on the Euphrates River.

Phosphate rock was produced from the Akashat open-pit mine in the west and, after some beneficiation, shipped by rail about 140 kilometers (km) northeast to a fertilizer complex at Al Qaim and other fertilizer plants at Baiji and near Basrah.

Salt was produced from seawater at the northern end of the Gulf and from salt lakes in the middle south.

Sulfur was produced from underground deposits at Mishraq on the west bank of the Tigris River about 50 km south of Mosul in the north. Additional byproduct sulfur came from processing oil and gas at several locations.

Natural gas produced in Iraq was mostly associated gas, most of which was used for domestic purposes. Main sources of associated gas are Ain Zalah, Butma, Kirkuk, and Bai Hassan in the north and Rumaila and Zubair in the south. Gas reserves were estimated to be about 3.4 trillion cubic meters (Arab Petroleum Research Center, 1997).

By 1990, Iraq had increased its crude oil production capacity to about 4.5 million barrels per day (Mbbl/d) with output at about 2.8 Mbbl/d. After sanctions were imposed, Iraq's oil production was restricted mostly to meet domestic needs with the exception of U. N. authorized exports to Jordan for processing in its Zarqa refinery. In 1996, Iraq's estimated production capacity was about 2.5 Mbbl/d. Exports to Jordan totaled about 88,000 barrels per day (bbl/d). Prior to the Gulf crisis and subsequent sanctions, Iraq's exports totaled about 2.3 Mbbl/d. In June 1996, the Organization of Petroleum Exporting Countries (OPEC) increased Iraq's production quota by 800,000 bbl/d to 1.2 Mbbl/d (Arab Petroleum Research Center, 1997).

Refining capacity was estimated at about 603,000 bbl/d. The major refineries were Baiji in the north (290,000 bbl/d), Basrah in the south (126,000 bbl/d), and Daurah in central Iraq (100,000 bbl/d). No new plans to increase current refining capacity were indicated other than the upgrade of existing plants to produce higher quality products and to address environmental concerns. Iraq's State Company for Oil Projects was, however, building a 290,000-bbl/d lube oil refinery at Babylon, 160 km south of Baghdad. The refinery will produce asphalt, some petroleum products, and lube oils.

Crude oil reserves were estimated to be more than 100 Gbbl as of January 1, 1997. The two largest producing oilfields, Kirkuk in the north and Rumaila in the south, had combined reserves of about 22 Gbbl. Other reserves for major producing fields are as follows: East Baghdad (central), about 11 Gbbl; Zubair (south), about 4.5 Gbbl; Bai Hassan (north), about 2 Gbbl; Buzurgan (east-central), about 2 Gbbl; Khabbaz (north), about 2 Gbbl; and Abu Ghirab (east-central), about 1.5 Gbbl. Of the 73 known oil prospects in the country, only 15 have been developed. Negotiations with foreign companies for production-sharing contracts to develop new oilfields are, however, ongoing, but are not likely to be initiated until the lifting of international sanctions.

The outlook is for increased energy and nonfuel mineral production once sanctions are removed.

## References Cited

Arab Petroleum Research Center, 1997, Arab oil & gas directory, 1997, Iraq: Paris, Arab Petroleum Research Center, p. 151-178.

PennWell Publishing Co., 1996, International petroleum encyclopedia, 1996: Tulsa, PennWell Publishing Co., p. 84-88.

## Major Sources of Information

Ministry of Industry, P.O. Box 2075, Baghdad.
Ministry of Oil, P.O. Box 6178, Al Mansoor City, Baghdad.

TABLE 1
IRAQ: ESTIMATED PRODUCTION OF MINERAL COMMODITIES 1/

(Thousand metric tons unless otherwise specified)

| Commodity 2/ | | 1992 | 1993 | 1994 | 1995 | 1996 |
|---|---|---|---|---|---|---|
| METALS | | | | | | |
| Iron and steel: Steel crude | | 100 | 300 | 300 | 300 | 300 |
| INDUSTRIAL MINERALS | | | | | | |
| Cement, hydraulic | | 2,000 r/ | 2,000 r/ | 2,000 r/ | 2,000 r/ | 2,100 |
| Nitrogen, N content of ammonia | | 200 | 500 | 500 | 500 | 500 |
| Phosphate rock: | | | | | | |
| Beneficiated 3/ | | 600 | 800 | 1,000 | 1,000 | 1,000 |
| Phosphorus pentoxide content | | 180 | 240 | 300 | 300 | 300 |
| Salt | | 250 | 300 | 300 | 250 | 250 |
| Sulfur, elemental: | | | | | | |
| Native, Frasch | | 250 | 250 | 250 | 250 | 250 |
| Byproduct 4/ | | 100 | 200 | 225 | 225 | 225 |
| Total | | 350 | 450 | 475 | 475 | 475 |
| MINERAL FUELS AND RELATED MATERIALS | | | | | | |
| Gas, natural: | | | | | | |
| Gross | million cubic meters | 2,480 | 5,000 | 5,000 | 5,000 | 5,000 |
| Dry | do. | 1,400 | 3,000 | 3,000 | 3,000 | 3,000 |
| Natural gas plant liquids | thousand 42-gallon barrels | 6,000 | 10,000 | 10,000 | 10,000 | 10,000 |
| Petroleum: | | | | | | |
| Crude (including lease condensate) | do. | 155,000 r/ | 187,000 r/ | 200,000 | 205,000 r/ | 213,000 |
| Refinery products | do. | 150,000 r/ | 160,000 r/ | 160,000 r/ | 160,000 r/ | 160,000 |

r/ Revised.

1/Includes data available through Dec. 15, 1997.

2/ In addition to commodities listed, the following also were produced but information is inadequate to reliably estimate output: gypsum for cement, plaster, mortar and other products; limestone for cement (about 1.3 tons per ton of finished cement), lime, and construction stone; clay and/or shale for cement (about 0.4 ton per ton of finished cement); other construction materials (e.g., clays for brick and tile, sand and gravel, stone); uranium and fluorine compounds from phosphate rock processing; industrial sand for foundry use and glass manufacture; and clays for ceramics and refractories.

3/ Estimated to contain 30% phosphorous pentoxide.

4/ Presumably from petroleum and natural gas processing.

### THE MINERAL INDUSTRY OF

# ISRAEL

### By Bernadette Michalski

Israel's indigenous mineral industry is based on the extraction of bromine, magnesium, and potassium bearing evaporites from the Dead Sea, phosphate rock mining, the manufacture of cement and fertilizers, and the production of minor quantities of crude oil and natural gas. Israel is the world's second largest producer of bromine and bromine compounds, the sixth largest producer of potash, and the seventh largest producer of phosphate rock. Mineral processing, based on imported raw materials, includes the cutting and polishing of gemstones, the refining of crude oil, and the production of crude steel. Domestic mineral fuel production represents less than 1% of the nation's energy requirements. *(See table 1.)* The source of imported crude oil is, for the most part, Mexico, while the bulk of coal imports are derived from South Africa. Imported crude oil and petroleum products accounted for nearly two-thirds of total energy requirements, while coal accounted for the remaining one-third. Virtually all electric power is coal-based and required the import of nearly 8 million metric tons (Mt) of coal in 1996. Imports are expected to climb to 11.5 Mt annually after the year 2000 when two new 560-megawatt plants come on-line in Ashkelon, according to Israel's National Coal Supply Corp.

The diamond cutting and polishing trade alone accounted for nearly one-fifth of the value of total imports and about one-fourth of the value of total exports. The United States is Israel's key trading partner. Exports to the United States included polished diamonds, other gemstones, and metals. Imports from the United States included transportation equipment, chemicals, jet fuel, rough diamonds, and precious stones.

The Government remained the principal owner of most of the country's mineral-related industries. The diamond cutting and polishing industry was privately owned as were the cement and potassium nitrate manufactures. The Government reduced its equity in Israel Chemical Ltd; the parent of Dead Sea Works, from 75% to 28% in 1995. In early 1996 an additional 24.9% was sold for $230 million reducing Government holdings in the corporation to 3.1%. This discharged the corporation the laws pertaining to Government companies.

An Israel Chemicals Ltd. subsidiary, the Rotem-Amfert-Negev Group, doubled its fertilizer granulation capacity in 1996 to 900,000 metric tons per year (t/yr) at a cost of $46 million.

The nation's sole cement producer, Nesher Israel Cement Enterprises, operated plants at Haifa, Tel Aviv, and near Jerusalem with a combined kiln capacity of more than 5 million metric tons per year. A new lime plant with the capacity of 90,000 t/yr of hydrated and specialty products came on-stream in 1996 at Mishor Rotem.

An Israeli-Egyptian consortium, the Middle East Oil Refinery, (MIDOR) was formed in mid-1996 for the construction and operation of a $1.3 billion export refinery near Alexandria, Egypt, involving Universal Oil Products and Conoco-Bechtel of the United States.

Israel's infrastructure includes industrial harbors at Ashdod, Elat, and Haifa. A total of 708 kilometers (km) of pipelines transport crude oil from the Port of Elat, on the Gulf of Aqaba, to the Haifa and Ashdod oil refineries. There are 89 km of natural gas pipelines and 290 km of refined petroleum products pipelines. About 85% of the traffic on Israel's 594-km rail system was involved in the transport of potash and phosphate materials from the Dead Sea and the Negev Desert to the Ports of Ashdod and Haifa.

Israel's mineral industry is export-oriented and its fortunes tend fluctuate with world commodity prices.. Trends to export higher-valued mineral products, such as custom fertilizers and high-grade chemicals are expected to continue.

**Major Source of Information**

Ministry of Energy and Infrastructure
234 Yaffo St.
Jerusalem
Telephone: 972 2 316-111
Fax: 972 2 381-444

**Major Publication**

Central Bureau of Statistics
Statistical Abstract of Israel 1995, No. 46
Tel Aviv, Israel 1996

## TABLE 1
## ISRAEL: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

| Commodity 2/ | 1992 | 1993 | 1994 | 1995 | 1996 e/ |
|---|---|---|---|---|---|
| METALS | | | | | |
| Iron and steel, steel, crude | 109,000 | 120,000 | 180,000 | 200,000 e/ | 200,000 |
| INDUSTRIAL MINERALS | | | | | |
| Bromine: | | | | | |
| Elemental | 135,000 | 130,000 | 130,000 e/ | 130,000 e/ | 160,000 |
| Compounds | 125,000 | 121,000 | 121,000 e/ | 121,000 e/ | 145,000 |
| Cement, hydraulic thousand tons | 3,960 r/ | 4,536 r/ | 4,800 r/ | 4,800 r/ e/ | 5,000 |
| Clays: | | | | | |
| Flint clays | 30,000 | 40,000 | 40,000 e/ | 40,000 e/ | 40,000 |
| Kaolin | 53,000 | 40,000 | 40,000 e/ | 40,000 e/ | 40,000 |
| Other | 3,000 | 8,500 | 8,500 e/ | 8,500 e/ | 8,500 |
| Fertilizer materials, manufactured: | | | | | |
| Nitrogenous, N content of ammonia and urea | 33,800 | 38,743 | 38,000 e/ | 38,000 e/ | 38,000 |
| Phosphatic, P content | 23,400 | 30,363 | 30,300 e/ | 33,000 r/ e/ | 33,000 |
| Potassic, K content | 18,600 | 16,007 | 16,000 e/ | 17,000 r/ e/ | 17,000 |
| Gypsum e/ | 47,663 3/ | 48,000 | 48,000 | 50,000 r/ | 50,000 |
| Lime e/ | 208,000 | 210,000 | 210,000 | 210,000 | 275,000 |
| Magnesia, Mg content | 38,600 | 42,223 | 42,200 e/ | 42,200 e/ | 42,200 |
| Phosphate rock: | | | | | |
| Beneficiated thousand tons | 3,595 | 3,680 | 3,961 | 4,063 | 3,800 |
| P2O5 content do. | 1,125 | 1,148 | 1,232 | 1,264 | 1,140 |
| Potash, K2O equivalent do. | 1,296 | 1,309 | 1,259 | 1,325 r/ | 1,300 |
| Salt, marketed (mainly marine) do. | 1,102 3/ | 1,123 | 1,120 e/ | 900 e/ | 800 |
| Sand: | | | | | |
| Glass sand | 100,000 | 82,700 | 176,300 r/ | 175,000 r/ e/ | 175,000 |
| Other e/ do. | 7,012 | 7,063 3/ | 7,060 | 7,060 | 7,060 |
| Sodium and potassium compounds, caustic soda | 29,459 r/ | 29,851 r/ | 32,765 r/ | 32,800 r/ e/ | 32,800 |
| Stone: e/ | | | | | |
| Crushed thousand tons | 17,100 | 31,515 | 31,500 | 31,500 | 31,500 |
| Dimension, marble do. | 12,000 | 12,000 | 12,000 | 12,000 | 12,000 |
| Sulfur: | | | | | |
| Byproduct from petroleum e/ do. | 60 | 60 | 60 | 60 | 60 |
| Sulfuric acid e/ do. | 130 | 130 | 130 | 130 | 130 |
| MINERAL FUELS AND RELATED MATERIALS | | | | | |
| Gas, natural: e/ thousand cubic meters | | | | | |
| Gross do. | 22,600 | 19,800 | 19,000 | 18,000 | 18,000 |
| Dry do. | 22,600 | 19,800 | 19,000 | 18,000 | 18,000 |
| Petroleum: | | | | | |
| Crude thousand 42-gallon barrels | 70 | 56 | 37 | 36 | 36 |
| Refinery products: | | | | | |
| Gasoline do. | 15,300 | 18,500 | 19,800 r/ | 20,000 r/ | 20,000 |
| Kerosene and jet fuel do. | 6,200 | 5,300 | 5,200 | 8,200 r/ | 8,200 |
| Distillate fuel oil do. | 18,800 | 21,000 | 20,500 | 22,600 r/ | 22,000 |
| Residual fuel oil do. | 24,350 | 28,500 | 28,000 | 23,000 r/ | 23,000 |
| Other do. | 10,500 | 13,200 | 13,000 | 12,000 r/ | 12,000 |
| Total do. | 75,150 | 86,500 | 86,500 r/ | 85,800 r/ | 85,200 |

e/ Estimated. r/ Revised.

1/ Table includes data available through May 15, 1997.

2/ In addition to the commodities listed, a variety of other crude construction materials are produced, but available information is inadequate to make reliable estimates of output levels.

3/ Reported figure.

## THE MINERAL INDUSTRY OF

# JORDAN

### By Bernadette Michalski

Industrial minerals, including construction raw materials were the major mineral commodities mined in Jordan. These include bulk phosphate rock, potash, and limestone. Jordan ranked sixth in global phosphate rock production and seventh in potash. While the bulk of mineral production is exported, lesser quantities of phosphate and potash are consumed in the domestic manufacture of fertilizers. Limestone is consumed by the domestic cement industry and in the production of soda ash in the Dead Sea Chemical Industries' complex.

The Provisional Law of Natural Resources 37 of 1966, as amended, was the basic mining law of Jordan. The law permitted private Jordanian or foreign national ownership of a mine or quarry with the provision that mine management be Jordanian.

The Public Power Law of 1996 transformed the Government-owned Jordan Electricity Authority (JEA) into a public shareholding corporation to be called the National Electricity Public Shareholding Company. The new company will be in charge of transmitting electrical power, building transmission lines, and operating the national grid and power stations formerly owned by JEA. The law also permits large industrial plants to build powerplants for their own use and to share power with industrial counterparts. The law establishes an independent regulatory commission to set power rates. This law is the first step in Jordan's new privatization policy.

Along with phosphate rock, finished fertilizers, and potash, Jordan produced significant amounts of other industrial minerals, such as aggregates, building stone, calcium carbonate, and dolomite. Jordan was also a significant regional cement producer. *(See table 1.)* Jordan's jewelry fabrication industry was maintained at approximately 10 tons but only a third of this was based on new gold.

Revenues for Jordanian bulk phosphate and fertilizer exports typically account for almost one-third of the nation's total export revenues.[1] The Jordon Cement Factories Co. reported a 16% increase in exports in the first 6 months of 1996 as compared with the same period in 1995. The first 6 months of 1996 also saw exports of 415,000 tons of cement of which 80% was exported to Syria (Middle East Economic Digest, 1996). Jordan imported most of its petroleum requirements from Iraq under a series of agreements which have been renewed annually since 1991 with the approval of the United Nations' Sanctions Committee. During this period, imports of crude oil from Iraq ranged from 40,000 barrels per day (bbl/d) to 60,000 bbl/d and petroleum products between 17,000 bbl/d and 25,000 bbl/d. All deliveries were made by truck.

The Jordan Natural Resources Authority (NRA) was the Government agency responsible for all activities related to the exploration and development of minerals and mineral fuels. The exploitation of the major mineral commodities of Jordan—cement, kaolin, phosphates, and potash—were all controlled by parastatals. Aggregates, basalt, calcium carbonate, dimensional stone, glass sand, and natural sand were produced by private-sector firms.

Anadarko Jordan Co., a unit of Anadarko Petroleum Corp. of the United States, signed a production-sharing agreement covering the 1.7 million hectare Safawi block in northeast Jordan. Anadarko agreed to spend at least $5 million during the first 2.5 years of exploration.

The Jordan Phosphate Mines Co., a company wholly owned by the Jordanian Government, has attempted to increase its global market share of phosphate and derivative products through aggressive marketing and third-party trading. The development of the phosphate reserves at the Ash Shidiya Mine, when fully completed, was intended to replace the existing Al-Hasa Mine and the mine at Wadi Al Abyad. This was expected to take place by the year 2000.

The Jordan Phosphate Mines Co. plans to issue a $100 million Eurobond offering on the international capital markets to finance part of a $250 million expansion at its Ash Shidiya Mine. A further $50 million will be raised from local sources (Middle East Economic Digest, 1997). The expansion is intended to more than double phosphate production at Ash Shidiya by 1998 to some 8 million metric tons per year (Mt/y). The uranium potential of the phosphate deposits were also evaluated. Company findings from four phosphate deposits in central and southern Jordan averaged 50 to 140 parts per million uranium content. Based on these results, the byproduct resources of Jordan are estimated to be 100,000 metric tons uranium.

Potash was produced by the Arab Potash Co. (APC) from brines at its Dead Sea facility. Since 1985, APC had sustained production at levels greater than 90% of its 1.8 Mt/yr design capacity.

The NRA estimated Jordanian phosphate rock reserves at 1 billion tons.

The International Finance Corporation was considering a loan of $6 million to Modern Aluminum Industries Co. Ltd. of Jordan to build and operate a $18 million aluminum extrusion plant at Giza. The plant is to produce 6,000 metric tons per year of aluminum extrusions. Three-fourths of the plant's output is expected to be sold in the domestic markets with the remainder for export to neighboring countries.

Jordan's infrastructure was sufficient for current mining operations. Railroads within Jordan consisted of 619 kilometers (km) of 1.05-meter-gauge single track. Crude oil pipelines within the country totaled 209 km. Primary export terminals were at the Port of Aqaba, where potash storage capacity was about 160,000 tons. The Jordanian Government was considering construction of a $300 million liquefied natural gas (LNG) terminal in Aqaba. The proposed Aqaba terminal is scheduled to receive about 2.5 million metric tons of LNG annually from Enron's planned liquefaction plant in Qatar.

---

[1] Where necessary, values have been converted from Jordanian dinars (JD) to U.S. dollars at the rate of JD0.70=US$1.00.

The possible construction of a new oil refinery and fertilizer plant in Aqaba along with a more agressive petroleum exploration program, indicated the Government's willingness to improve the minerals sector of the economy. The NRA claimed that 63% or 60,000 square kilometers of Jordan had been unexplored for economic minerals or mineral fuels. Jordan's apparent lack of domestic energy sources, mainly hydrocarbons, was expected to continue to stress the nation's balance of trade owing to fuel importation costs.

## References Cited

Middle East Economic Digest, 1996, Jordan: Middle East Economic Digest, v. 40, no. 30, p. 12.

——1997, Jordan: Middle East Economic Digest, v. 41, no. 20, p. 13.

## Major Source of Information

Jordan Natural Resources Authority
P.O. Box 220
7 Amman, Jordan
Telephone: 962 (6) 811300
Fax: 962 (6) 811866

## Major Publication

Chronique de la Recherche Miniere, Number 524, 1996
Ammam, Jordan

TABLE 1
JORDAN: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

| Commodity | | 1992 | 1993 | 1994 | 1995 | 1996 e/ |
|---|---|---|---|---|---|---|
| Cement, hydraulic | thousand tons | 3,130 | 6,400 | 6,400 e/ | 3,508 r/ | 3,610 |
| Feldspar e/ | | 2,467 2/ | 2,500 | 2,500 | 2,500 | 2,500 |
| Gypsum | | 83,038 | 194,981 | 193,000 e/ | 190,000 e/ | 190,000 |
| Iron and steel, steel, crude e/ | | 30,000 | 30,000 | 30,000 | 30,000 | 30,000 |
| Kaolin | | 34,446 | 47,174 | 47,200 e/ | 47,500 r/ e/ | 47,500 |
| Lime | | 7,115 | 7,267 | 7,270 e/ | 7,275 e/ | 7,275 |
| Petroleum: | | | | | | |
| Crude 3/ | thousand 42-gallon barrels | 16 | 11 | -- | -- | -- |
| Refinery products: | | | | | | |
| Liquefied petroleum gas | do. | 1,300 | 1,500 | 1,500 e/ | 1,500 e/ | 1,500 |
| Gasoline | do. | 3,895 | 4,100 | 4,130 e/ | 4,500 e/ | 4,500 |
| Jet fuel | do. | 1,650 | 1,600 | 1,650 r/ e/ | 1,700 e/ | 1,700 |
| Kerosene | do. | 2,350 | 2,300 | 2,350 e/ | 2,350 e/ | 2,350 |
| Distillate fuel oil | do. | 5,610 | 5,500 | 6,050 r/ e/ | 6,000 e/ | 6,000 |
| Residual fuel oil | do. | 5,625 | 5,240 | 6,390 r/ e/ | 6,000 r/ e/ | 6,000 |
| Other | do. | 2,400 | 2,350 | 2,000 r/ e/ | 2,200 e/ | 2,200 |
| Total | do. | 22,830 | 22,590 | 24,070 r/ | 24,250 r/ e/ | 24,250 |
| Phosphate: | | | | | | |
| Mine output: | | | | | | |
| Gross weight | thousand tons | 4,296 | 3,565 r/ | 4,218 | 4,983 | 5,355 |
| P2O5 content | do. | 1,418 e/ | 1,176 r/ | 1,399 | 1,655 | 1,765 |
| Phosphatic fertilizers | | 553,600 | 490,788 r/ | 749,700 | 775,000 e/ | 775,000 |
| Potash: | | | | | | |
| Crude salts | thousand tons | 1,261 | 1,511 | 1,550 | 1,790 r/ | 1,800 |
| K2O equivalent | do. | 756 | 822 | 930 | 1,075 r/ | 1,080 |
| Salt | | 56,000 | 26,000 | 26,000 | 25,000 e/ | 25,000 |
| Stone: | | | | | | |
| Limestone | | 115,397 | 5,336 | 5,340 e/ | 5,340 e/ | 5,340 |
| Marble | | 200,000 | 112,250 | 112,000 e/ | 112,000 e/ | 112,000 |

e/ Estimated. r/ Revised.
1/ Table includes data available through July 1, 1997.
2/ Reported figure.
3/ The Hamza Field was closed in mid-1993.

### THE MINERAL INDUSTRY OF

# KUWAIT

### By Bernadette Michalski

In recent years, output from metal fabricating and cement plants have lessened the necessity of Kuwait importing these products. The preponderant sector of the mineral industry continues to be the production and refining of crude oil. The oil industry accounted for about 40% of the gross domestic product (GDP), generated nearly 95% of export revenues, and provided 90% of government revenues. The production for export of such value-added commodities as ammonia and urea will include ethylene-based petrochemicals after the nation's first petrochemical plant begins production in 1997.

## Government Policies and Programs

Kuwait's many investments, which included participation in foreign petroleum exploration, acquisition of foreign petroleum refining and distribution networks, and participation in overseas petrochemical facilities, have fostered an economy with globally dispersed assets.

Under its privatization plan, the Kuwaiti Government, which employed most of the work force, proposed selling state enterprises during the next 5 years. The plan included shedding a total of $2.68 billion in equity distributed among 62 companies and privatizing services that were being subsidized or provided free by the Government. These services included electric power production, transportation, and communications. The Government planned to increase the contribution of the private sector to the GDP from 25% to 31% by 2000. In support of this privatization program, 17 state-owned companies had been wholly or partially privatized by year-end. Kuwait Petroleum Corporation. (KPC) realized realized $435 million from the sale of American assets owned by its subsidiary, Santa Fe International Corp. and an additional $1.23 billion from the sale of North Sea assets owned by Santa Fe that were purchased at auction by Norway's Saga Petroleum Corp.

## Environmental Issues

The environmental damages resulting from the Iraqi occupation had not yet been fully realized. Because there was no precedent upon which to draw to make an assessment, it was expected to be some time before the full extent of the damage could be understood.

## Production

The Organization of Petroleum Exporting Countries extended Kuwait's crude oil production quota at the same level of 2 million barrels per day (Mbbl/d) for 1996. This quota level has been assigned to Kuwait since the fourth quarter of 1993. Kuwait's crude oil production for 1996 averaged 2 Mbbl/d, including about 200,000 barrels per day (bbl/d) from the Divided Zone shared with Saudi Arabia. *(See table 1.)* This is the highest production level attained since 1979 when output was 2.5 Mbbl/d.

## Trade

Total exports, mostly hydrocarbon-related, were valued at $15.2 billion. Total imports, principally vehicles and other consumer goods, were valued at $8 billion. Less crude oil was available for export as combined throughput capacity at the nation's three refineries was upgraded to 895,000 bbl/d from 750,000 bbl/d in 1995. The principal market for crude oil was Japan, which imported about 500,000 bbl/d. European imports averaged about 290,000 bbl/d; however, much of the crude oil was delivered to Kuwait-owned European refineries and the resulting products were marketed through the Kuwait-owned distribution system. The United States imported 236,000 bbl/d of mostly crude and unfinished oil from Kuwait, accounting for 2.5% of the U.S. petroleum imports for the year (Energy Information Administration, 1996).

## Structure of the Mineral Industry

The Government of Kuwait imposed few restrictions on trade or financial flows and placed considerable emphasis on the private sector to develop the economy. The petroleum and natural gas extraction and processing industries, however, were under Government control.*(See table 2.)* Total control of the Kuwait Oil Corporstion (KOC) and the Kuwait National Petroleum Company (KNPC) has been in effect since 1975.

The Government established a state umbrella company for hydrocarbon operations KP in 1980. This organization controlled all the state hydrocarbon companies and managed Government share holdings in various oil ventures, including those operations in the Divided Zone and the acquired interests in foreign operations.

Despite the liquidation of several billion dollars in stocks and bonds since the Iraqi invasion, Kuwait retained substantial worldwide investments, including an extensive refining and distribution network in Western Europe, as well as downstream investments in Eastern Europe, India, and Southeast Asia.

## Commodity Review

### *Metals*

Arabian Light Metals Co. operates a 5,000-metric-tons-per-year (t/yr)-capacity aluminum extrusion plant. The company used billet imported from Bahrain, Dubai, and Egypt.

Kuwait consumes about 0.5 million metric tons per year (Mt/yr) of steel reinforcing bars. The construction of an $80 million mill is under consideration as a joint venture with Iran, which is expected to supply the Kuwait mill with direct reduced iron from the National Iranian Steel Company.

### *Industrial Minerals*

**Cement.** The heavy construction demands resulting from damages related to the Gulf War required large imports of cement. Any further construction programs are within the limits of the 2 Mt/yr domestic kiln capacity. The Kuwaiti cement industry imports all of its clinker requirements.

**Fertilizers.**—The Petrochemical Industries Company (PIC) operated the Shuaybah Fertilizer Complex, which had the capacity to produce almost 1 Mt/yr of ammonia and 800,000 t/yr of urea. The bulk of the complex's urea output is exported to China, Japan, and the Philippines. Ammonia exports, by order of volume, are destined for India, The Republic of Korea, Taiwan, Jordan, Tunisia, Turkey, Spain, and Greece.

### *Mineral Fuels*

**Natural Gas.**—Fully restored since the Gulf War, the gas system has the capacity to process associated gas from as much as 3 Mbbl/d of oil production (current production is only 2 Mbbl/d), stripping liquids for export, and using dry gas for Kuwait's domestic needs—fuel for electric power and feedstock in fertilizer and eventually petrochemical production.

Kuwait's associated natural gas gathering network delivers the gas to three gathering stations distributed in different regions within the country. From each of these locations it is piped to Shuaybah for fractionation. Associated natural gas from the Raudhatain and the Sabiriya Fields near the northern border with Iraq was processed in northern Kuwait, and a mixed liquids stream was delivered by pipeline to the fractionator at Shuaybah. Natural gas from the Minagish, the Umm Gudair, and the South Umm Gudair Fields, near the western border with Saudi Arabia, flowed as wet gas to the processing plant at Shuaybah. Natural gas from the Burgan and the Maqwa-Ahmadi Fields was processed at two field recovery plants. The recovered liquids were then delivered by pipeline to Shuaybah for fractionation.

**Petroleum.**—Production.—The bulk of Kuwait's 2 Mbbl/d output was derived from the Burgan complex, which included the Maqwa and the Ahmadi Fields.

The country's sustainable crude oil production capacity is about 2.5 Mbbl/d, including more than 200,000 bbl/d in the Divided Zone. The Government plans to augment sustainable crude oil production capacity to 3 Mbbl/d by 2000 and a further increase to 3.5 Mbbl/d by 2005. Much of the expansion in capacity was expected to result from the development of the light crude oil reservoirs in the deep Marat, Naja, and Sarjelu Formations.

Refining.—During the Gulf War, overall damage to the Mina al Ahmadi refinery was relatively light acompared with that to the Mina Abdullah and the Shuaybah refineries. A vigorous petroleum refinery reconstruction program was implemented. As a result, total domestic refining capacity was 750,000 bbl/d by the start of 1995, and increased to 830,000 bbl/d in 1996. As a guaranteed outlet for its crude oil, KPC continued acquiring equity in overseas refining centers, progressing toward achieving its target of attaining 400,000 bbl/d of refining capacity in Asia alone. Plans include a joint venture with the Indian Oil Corp.(IOC) to construct a refinery in the State of Orissa. The refinery's initial capacity was planned at 120,000 bbl/d eventually to be expanded to 180,000 bbl/d. KPC and IOC will each have 26% ownership with the remainder offered for public subscription in India. Similar joint-venture refineries were planned in China, Pakistan, and Thailand.

Kuwait's refining equity in Europe was about 150,000 bbl/d, mostly from refineries in Rotterdam, the Netherlands, and in Gulfhaven, Denmark. In September 1995, KPC reportedly reached an agreement with Italy's Agip for a 50% stake in the 300,000- bbl/d Milazzo refinery in Sicily.

Petrochemicals.—Equate, Kuwait's first petrochemical company, with equity held by PIC, Union Carbide Corp. of the United States, and the Bubiyan Investment Co. of Kuwait, began plant construction at Shuaybah in late 1995; completion is anticipated in 1997. The plant will include a 650,000-t/yr-capacity ethane cracker, and will produce 450,000 t/yr of high-density and linear low-density polyethylene, and 350,000 t/yr of ethylene glycol.

Petroleum Coke.—KNPC is considering the construction of a 300,000-t/yr-capacity petroleum coke plant at the Mina Abdullah refinery. The output would be exported within the Gulf region to supply aluminum smelters that are currently receiving petroleum coke imported mostly from the United States.

## Reserves

Kuwait's proven reserves of crude oil as of January 1, 1997, were officially estimated by KOC at 96.5 billion barrels, including 2.5 billion barrels representing Kuwait's share of the Divided Zone reserves. Kuwait enjoys a reserve-to-production ratio of 132 years. The bulk of crude oil reserves were located in the Greater Burgan Field, containing about 65 billion barrels.(Arab Oil & Gas Directory, 1997.

Natural gas reserves were 1,400 billion cubic meters (Arab Oil & Gas Directory, 1997). The reserves were based entirely on associated natural gas because intensive exploration programs during the past decade uncovered no nonassociated gas reservoirs.

## Infrastructure

The pipeline network and storage facilities supporting petroleum production, processing, and transportation were fully restored. The pipeline network totals 390 kilometers of crude, product, and natural gas lines. KOC operates all crude oil and natural gas lines, and KNPC operates all product pipelines. Kuwait has four electric power stations with a combined capacity of 6,550 megawatts. These plants also incorporate seawater desalination facilities and have a combined capacity of 216 million gallons per day. The Ministry of Electricity and Water is expanding and upgrading the national grid through the construction of several new substations and transformer stations to sustain Kuwait's electricity consumption, which the Ministry estimates is rising at a rate of 8% to 10% per year.

## Outlook

The recovery of oil prices in 1995 and even more so in 1996 has served as an impetus to the economy with exports climbing to nearly twice the value of imports. The Government of Kuwait has filed claims amounting to nearly $95 billion with the United Nations' Compensation Commission in Geneva for damages from Iraq's invasion in 1990. These claims cover only damages to oil reservoirs and loss of crude oil after Iraqi forces set Kuwait's oil fields ablaze. The U.N. Security Council Resolution 687 provided for receipt of a portion of Iraq's oil revenues in compensation for the human and material losses suffered.

After consultations with the International Monetary Fund and the World Bank, Kuwait implemented steps to promote privatization, economic liberalization, and a reduction in the welfare state. To ease the budget deficit, Kuwait plans to reduce public spending by 20% through fees on public services and by privatizing state-owned enterprises.

Domestic refineries were being upgraded. New joint-venture refining projects in Europe and Asia will provide secure outlets for Kuwait in the future—particularly as Kuwait Export crude can be processed only by refiners with adequate desulfurization capacity. If world oil demand remains strong and Government programs for cost cutting and privatization continue to be successful, then the Kuwait budget deficit can be dissolved in this decade.

## References Cited

Arab Oil & Gas Directory, 1997, Arab Petroleum Research Center: Paris, 1997. p.200, 207.

Energy Information Administration, 1996, Petroleum Supply Annual, 1996: V. 2 DOE/EIA-0340(96)/2 p. 278-301, June.

## Major Sources of Information

Kuwait Petroleum Corp. (KPC)
P.O. Box 26565-Safat
13126, Kuwait
Telephone: (965) 245-5455 and (965) 245-2686
Kuwait Oil Co.
P.O. Box 9758-Ahmadi
61008, Kuwait
Telephone: (965) 398-9111
Kuwait National Petroleum Co.
P.O. Box 70-Safat
13001, Kuwait
Telephone: (965) 242-0121
Petrochemical Industries Co.
P.O. Box 1084
Safat 13011, Kuwait
Telephone: (965) 244-8280
Fax: (965) 244-7159

## TABLE 1
## KUWAIT: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

| Commodity | | 1992 | 1993 | 1994 | 1995 | 1996 e/ |
|---|---|---|---|---|---|---|
| Chlorine | | -- | 25,000 | 35,000 | 50,000 r/ | 50,000 |
| Cement e/ | thousand tons | 533 r/ | 500 | 500 r/ | 500 r/ | 500 |
| Clay products, nonrefractory: Sand lime bricks e/ | cubic meters | 100,000 | 100,000 | 100,000 | 100,000 | 100,000 |
| Lime: Hydrated and quicklime e/ | | 5,000 | 35,000 | 35,000 r/ | 35,000 r/ | 35,000 |
| Natural gas: 2/ | | | | | | |
| Gross | million cubic meters | 3,600 | 5,170 | 7,560 r/ | 10,870 r/ | 11,000 |
| Dry | do. | 2,040 | 4,470 | 5,970 r/ | 9,280 r/ | 9,400 |
| Natural gas liquids | thousand 42-gallon barrels | -- r/ | 40,000 | 42,000 | 45,000 r/ e/ | 45,000 |
| Nitrogen: N content of ammonia | | 140,000 | 317,000 r/ | 320,000 r/ | 325,000 r/ e/ | 325,000 |
| Petroleum: | | | | | | |
| Crude 2/ | thousand 42-gallon barrels | 380,000 | 683,300 | 742,000 | 752,265 | 752,630 |
| Refinery products: | | | | | | |
| Gasoline, motor | do. | 9,380 | 10,183 r/ | 21,316 r/ | 16,170 r/ | 18,500 |
| Kerosene | do. | 11,970 | 16,315 | 45,100 r/ | 49,494 r/ | 17,000 |
| Distillate fuel oil | do. | 20,440 | 43,360 r/ | 90,702 r/ | 88,914 r/ | 36,000 |
| Residual fuel oil | do. | 61,685 | 72,817 r/ | 88,290 r/ | 66,940 r/ | 68,500 |
| Other | do. | 29,930 r/ | 21,316 | 40,150 r/ | 78,402 r/ | 35,000 |
| Total | do. | 133,405 r/ | 163,991 r/ | 285,558 r/ | 299,920 r/ | 175,000 |
| Salt | | 800 | 40,860 r/ | 45,000 r/ | 100,000 r/ | 100,000 |
| Sodium and potassium compounds: Caustic soda | | 16,000 | 25,000 | 30,000 | 60,000 r/ | 40,000 |
| Sulfur: | | | | | | |
| Elemental, petroleum byproduct | | 50,000 r/ | 175,000 r/ | 200,000 r/ | 559,000 r/ | 576,000 |
| Sulfuric acid | | NA | 5,000 | 5,000 e/ | 10,000 r/ e/ | 10,000 |
| Urea | | 140,000 | 300,000 r/ | 400,000 r/ | 400,000 r/ e/ | 400,000 |

e/ Estimated. r/ Revised. NA Not available.

1/ Table includes data available through Oct. 1, 1997.

2/ Includes Kuwait's share of production in the Kuwait-Saudi Arabia Divided Zone.

## TABLE 2
## KUWAIT: STRUCTURE OF THE MINERAL INDUSTRY FOR 1996

**(Thousand metric tons unless otherwise specified)**

| Commodity | | Major operating companies and major equity owners | Location of facilities | Annual capacity |
|---|---|---|---|---|
| Caustic soda | | Petrochemical Industries Co. (Government, 100%) | Shuaybah | 30 |
| Chlorine | | Petrochemical Industries Co. (Government, 100%) | Shuwaikh | 25 |
| Do. | | do. | Shuaybah | 33 |
| Nitrogen: | | | | |
| Ammonia | | Petrochemical Industries Co. (Government, 100%) | do. | 1,100 |
| Urea | | do. | do. | 900 |
| Petroleum, crude | million barrels | Kuwait Oil Co. (Government, 100%) | Burgan | 550 |
| Do. | do. | do. | Raudhatain | 95 |
| Do. | do. | do. | Sabiriya | 58 |
| Do. | do. | do. | Ahmadi | 20 |
| Do. | do. | do. | Minagish | 25 |
| Do. | do. | do. | Umm Gudair | 25 |
| Do. | do. | do. | Maqwa | 25 |
| Do. | do. | do. | Bahra | 15 |
| Do. | do. | do. | Ratqa | 5 |
| Do. | do. | Wafra Oil Co. (Saudi Arabian Texaco, 50 %; Kuwait Oil Co., 50%) | Wafra | 35 |
| Do. | do. | do. | South Fuwaris | 2 |
| Do. | do. | do. | South Umm G | 10 |
| Do. | do. | Arabian Oil Co. (Japanese Petroleum Trading Co., 80%; Saudi Arabia, 10%; Kuwait, 10%) | Khafji | 100 |
| Do. | do. | do. | Hout | 10 |
| Petroleum, products | do. | Kuwait National Petroleum Co. (Government, 100%) | Mina Al-Ahma | 400 |
| Do. | do. | do. | Shuaybah | 150 |
| Do. | do. | do. | Mina Abdulah | 245 |
| Petrochemicals: | | | | |
| Ethylene | | Equate Petrochemical Complex (Petrochemical Industries (Co., 45%; Union Carbide Corp, 45%, Bubiyan, 10%) | Shuaybah | 650 1/ |
| Polyethylene | | do. | do. | 450 1/ |
| Ethylene glycol | | do. | do. | 350 1/ |

1/ In operation by 1997.

### THE MINERAL INDUSTRY OF

# LEBANON

### By Bernadette Michalski

Domestic mineral output was limited in 1996 to the production of salt and the quarrying of raw materials for the construction industry, particularly limestone and silica for cement manufacture. The petroleum-processing industry relied on imported crude oil until the closure of its two refineries; the steel industry relied on imported scrap as raw material. Actual production data have not been reported in recent years, but estimates have been made based upon the best available information. *(See table 1.)*

Trade in mineral commodities increased momentum in spite of the fragile stability of the region. Iraqi crude oil and petroleum products shipments were replaced by Syrian crude oil and, for the most part, Syrian petroleum products. Crude oil imports were suspended in mid-1992 with the closure of the Tripoli refinery. Petroleum product consumption has been met entirely through imports since that time. Petroleum product imports totaled 4.2 million metric tons (Mt) (about 80,000 barrels per day) in 1996 representing a volume increase of about a 5% over 1995. Fuel oil imported by the Government for Electricité du Liban accounted for most of the increase. Lebanon's petroleum import costs in 1996 were $769 million[1] compared with $630 million in 1995, representing a value increase of about 22% (Arab Petroleum Research Center, 1997). In 1996, imports of gasoline, domestic heating oil, and kerosene were appreciably diminished by volume but had little effect on product import costs due to increased prices.

Lebanon was basically a private-sector-oriented economy. Most mineral operations in Lebanon in 1996 remained privately owned, including all cement plants, steel mills, and building material quarries. However, petroleum imports, as well as the Nation's inactive refineries near Tripoli and Sidon, were controlled by the Ministry of Industry and Petroleum. The Zahrani Refinery near Sidon suspended operations in mid-1989. The Tripoli refinery supplied about 15% of the Nation's petroleum product consumption requirements until mid-1992, when it also suspended operations, largely due to lack of funds to purchase crude oil. Consideration is being given to the rehabilitation and upgrading of the refinery at a projected cost of $130 million. Any plan to repair the war-damaged Zahrani Refinery was abandoned in favor of completely scrapping the refinery because of the obsolescence of its equipment. It was decided in early 1996 to transform the Zahrani facility to a petroleum product storage area.

The bulk of cement manufacturing was centered in the north coastal region of Chekka near abundant limestone and silicon deposits and deep-draft port facilities. Cimenterie National obtained a loan through the International Finance Corp. to increase capacity by 50% to 1.5 million metric tons per year (Mt/yr). The additional capacity was to be available by 1997. Other cement producers were the Société des Ciments Libanais, currently operating a 1.5-Mt/yr-capacity plant with contracts to expand to 2 Mt/yr, and the Sibline Cement Co. operating a 0.32-Mt/yr-capacity plant under expansion to 1.25 Mt/yr, and Société Libanaise des Ciments Blancs. The demand for cement has grown from 1.4 Mt/yr in 1992 to nearly 4 Mt/yr in 1996 as major public reconstruction projects were under way.

Power-generation rationing was abolished on January 1, 1996, following the completion of the rehabilitation of 29 power stations with a combined capacity of 1,057 megawatts (MW). These included nine thermal stations with a combined capacity of 836 MW and 20 hydroelectric stations with a combined capacity of 221 MW. Electricity generation increased by 50% in 1996 reaching 7.5 billion killowatt hours. About one-third of this power was consumed by industry.

As part of the economic recovery plan, Lebanon sought to encourage investment by reducing the corporate income tax by 75% and establishing even more favorable tax structures for offshore holding companies.

#### Reference Cited

Arab Petroleum Research Center, 1997, Arab Oil & Gas Directory: Arab Petroleum Research Center, Paris, p. 223-232.

#### Major Source of Information

Ministry of Oil and Industry
Assaad Kalout Bldg. Sami Solh Blvd.
Beirut, Lebanon
Telephone: [961] 1 427114
Fax: [961] 1 427004

---

[1] Where appropriate, values have been converted from Lebanese pounds to U.S. dollars at the rate of L£1,552=US$1.00.

## TABLE 1
## LEBANON: ESTIMATED PRODUCTION OF MINERAL COMMODITIES 1/

| Commodity | | 1992 | 1993 | 1994 | 1995 | 1996 |
|---|---|---|---|---|---|---|
| Cement, hydraulic | thousand metric tons | 1,500 | 2,500 | 2,800 | 3,000 | 4,000 |
| Gypsum | metric tons | 2,000 | 2,000 | 2,000 | 2,000 | 3,000 |
| Iron and steel, metal, semimanufactures | do. | 80,000 | 80,000 | 80,000 | 80,000 | 80,000 |
| Lime | do. | 15,000 | 25,000 | 28,000 | 30,000 | 30,000 |
| Petroleum refinery products: 2/ | | | | | | |
| Liquefied petroleum gas | thousand 42-gallon barrels | 11 3/ | -- | -- | -- | -- |
| Gasoline | do. | 533 3/ | -- | -- | -- | -- |
| Kerosene | do. | 30 3/ | -- | -- | -- | -- |
| Distillate fuel oil | do. | 665 3/ | -- | -- | -- | -- |
| Residual fuel oil | do. | 1,030 3/ | -- | -- | -- | -- |
| Other | do. | 200 3/ | -- | -- | -- | -- |
| Total | do. | 2,469 3/ | -- | -- | -- | -- |
| Salt | metric tons | 3,000 | 3,000 | 3,000 | 3,000 | 3,000 |

1/ Table includes data available through Nov. 1, 1997.

2/ The first of Lebanon's two petroleum refineries ceased operation in 1989 and may be converted to a product storage center. The second refinery suspended operation in mid-1992 and is under consideration for refurbishment.

3/ Reported figure.

## THE MINERAL INDUSTRY OF

# OMAN

### By Bernadette Michalski

Major developments in the natural gas industry highlighted Oman's mineral industry sector in 1996. Key sales and purchase agreements were signed to implement the liquefied natural gas (LNG) project that will provide for the delivery of 4.1 million metric tons per year (Mt/yr) of LNG to the Korea Gas Corp. for at least 25 years. This represents the largest volume of LNG ever contracted between a seller and a single buyer. Several agreements to facilitate downstream processing also were concluded in 1996. They included a $2 billion financing package for the liquefaction plant at Al Ghalilah, which was signed in November 1996 between Oman and several banks and export credit agencies. Although petroleum and natural gas underwrite Oman's developing economy, providing nearly 90% of Government revenues, other commercially viable mineral ventures include the mining of chromite, the refining of copper with gold and silver as byproducts, the manufacturing of cement, and the producing of crushed and dimension stone and sand and gravel. The main industrial facilities also included a petroleum refinery and natural gas processing plants. The mineral industry accounted for about one-half of the gross domestic product. The Government introduced the 1996-2000 Development Plan, which provides for greater economic diversification.

The Government had engaged in several international ventures to diversify and broaden its hydrocarbon revenue base. In addition to the LNG project to supply growing Asian markets, Oman has entered into agreements for the construction of two 120,000 barrel-per-day-(bbl/d) petroleum refineries in partnership with India's Hindustan Petroleum Co. and Baharat Oil Co. and the construction of a 130,000-bbl/d refinery in Thailand in partnership with Caltex and the Petroleum Authority of Thailand for which Oman was to provide 60% of crude oil throughput. The Government's participation in the Caspian Pipeline Consortium transporting crude oil from the Tengiz Field in Kazakstan to the Black Sea was scaled down from 25% equity to 7% equity. Plans for the construction of a deep-sea pipeline capable of delivering 50 million cubic meters per day ($Mm^3/d$) of Omani natural gas to India's west coast was abandoned in late 1996 in favor of devoting finances to the LNG project. The Anglo-Dutch Shell Group, however, is planning to invest in a LNG regasification unit in the southern Indian state of Tamil Nadu at Ennore, making possible the import of Omani LNG.

The Nimr Petroleum Co. (Saudi Arabia) signed a $50.5 million exploration agreement covering a concession of 15,000 square kilometer ($km^2$) in northeast Oman over an 8-year period. Other Omani Government oil concessions awarded in 1996 were Triton Energy (Dallas), Phillips Petroleum Oman, Japan Petroleum Exploration Co., and a joint venture between Atlantic Richfield Co. of the United States and Partex (Oman) Corp.(Middle East Economic Digest, 1996b).

Crude oil production increased to record levels as development activity and enhanced recovery operations continued. Only 5% of the domestic output was refined in Oman. One-half of the resulting product yield was absorbed by the domestic market. Surplus refined products, mostly fuel oil, were exported. Chromite production, entirely destined for export markets, was hampered by diminished prices. Copper ore output ceased, largely because of declining grade at the older surface mines and difficult conditions at the underground Aarja Mine. The smelter and refinery operated by the Oman Mining Co. imported concentrates for toll and custom smelting. *(See table 1.)*

Oman exported about 95% of its crude oil production in 1996, or about 300 million barrels (bbls). Both the heavier crudes of the south and the lighter crudes of the north are gathered and blended into the Omani Export Blend, which averaged $19.10 per barrel, an increase of 17% over 1995 prices. The bulk of Oman's petroleum exports were destined for Asia. Japan alone received about one-third of the Oman's petroleum exports. Other importers, included China, India, Korea, Singapore, and Thailand.

The Petroleum and Mineral Law of Oman, effective since January 1, 1975, governed mineral activities in the country. All minerals are considered Government property until extracted. The royalty tax rate was fixed by a 1976 decree at 20% of the value of production. The Government maintained a majority interest in most companies; however, foreign partnerships were encouraged. The Oman Chromite Co. has limited Government participation with major equities held by private interests. A reform of the complicated tax system to broaden foreign ownership was introduced in October 1996 allowing local companies to make overseas investments without jeopardizing their tax status.

Construction was underway on the expansion project at the Rusayl cement plant. A new $110 million production line is planned parallel to the existing plant. By 1998 when the expansion program is completed, the clinker capacity will have increased from 600,000 metric tons per year (t/yr) to 1.2 Mt/yr (Industrial Minerals, 1996).

A $3 billion, 480,000-t/yr capacity aluminum smelter is to be constructed in the Sohar area. Government approval for the Sohar Aluminium Smelter Co. was obtained in late 1996. Shareholders include Charus Enterprises of the United States, the Hong Kong branch of the China National Nonferrous Metals Industry Corporation (CNNC), and Oman's WJTowell & Co. The smelter is to be constructed in conjunction with a natural-gas-fueled power station of 1,800 megawatt (MW) capacity and a 30-million-gallons-per-day desalination plant. Brown and

Root of the United States is to provide project management services (Middle East Economic Digest, 1996a). Central to the development of the smelter was a guaranteed supply of gas for power and a well-developed supporting infrastructure, including a fully fledged industrial port. These projects were made possible by the 25-year guaranteed LNG purchase agreement.

Copper cathodes, the bulk of which were processed from imported concentrates to more fully utilize the refining capacity, were exported from the Port of Majis, about 17 kilometers (km) northwest of Sohar.

The Government concluded the agreement in 1996 with the Japanese International Cooperation Agency and the Metal Mining Agency of Japan for the exploration for copper, gold, silver, and other minerals on a 2,900-km$^2$ area near the Batina Coast between Rustaq and Saham.

About 7 Mm$^3$/d of natural gas was produced from the Yibal Field, while the Fahud and Sayh Nuhaydah Fields each accounted for almost 1 Mm$^3$/d. The collection and processing of natural gas in Oman was networked to three plants: the Fahud gas processing plant, the 2.2-Mm$^3$/d-capacity Sayh Nuhaydah gas treatment plant, and the 16.6-Mm$^3$/d-capacity Yibal gas processing plant. The Government Gas System (GGS) received more than one-third of production, which was primarily used as fuel for electric power generation. It was also piped to the Sultan Qaboos University, and connecting lines extend up the Batinah Coast to Sohar at the site of the copper refinery. The GGS included a pipeline that carries gas from Yibal to the Al-Ghubra desalinization and powerplant and to the Rusayl Industrial Estate, near Muscat. A pipeline also extends south from Sayh Nuhaydah to Zufar, transporting gas for use in the southern oilfields. Field operations, including reinjection, absorbed about one-half of the natural gas produced. Only about 5% is flared or lost in transmission. The Rusail, Sohar, and Al-Ghubra power stations consume 90% of the dry gas produced at Yibal. The 90-MW Al-Manah power-plant was completed in September 1996 at a cost of $215 million, representing Oman's first private sector power scheme. Plans for Oman's largest power and water scheme at Batqa have been postponed. Three industrial power schemes are proceeding: the 60-MW power station for Petroleum Development Oman (PDO) as part of the development of the Saih Rawl Gas Fields, the 60 MW plant for Oman Cement Co. at Rusail, and a 1,800-MW powerplant at Sohar to accommodate the new aluminum smelter.

The Government, reserving a majority equity position of 51% in Oman Liquefied Natural Gas LLC, a joint venture, including Royal Dutch Shell, 34%; Total, 6%; Mitsubishi and Mitsui each 3%; Partex, 2%; and Itochu, 1%, is responsible for natural gas liquefaction, shipping, and marketing. The group's proposed $9 billion natural gas liquefaction project was expected to yield 6.6 million metric tons (Mt) of LNG annually with a proposed startup date in the year 2000. The LNG plant site is to be at Bimmah, 150 km southeast of Muscat.

PDO accounted for about 95% of the nation's total petroleum production and most of the nation's exploration activities. The company operated more than 1,600 crude oil production wells from 72 producing fields, which were linked to 40 gathering stations. Occidental Petroleum is the largest of the country's four other equity producers and contributed about 38,000 bbl/d. Other producers in 1996 were Japex, Elf Aquitaine and IPC. Petroleum production averaged 883,000 for the year; however output in the last quarter of 1996 averaged 900,000 bbl/d suggesting that Oman's target of producing 1 million barrels per day (Mbbl/d) of crude oil by 2000 is within reach.

Oman's single refinery, Mina Al-Fahal, has a capacity of 85,000 bbl/d and is dedicated to meeting local demand. A second refinery is being considered for the southern city of Salalah.

Oman proceeded with plans to develop a $900 million petrochemical complex. The plant is due to come on stream between 2001 and 2002. It will produce about 450,000 t/yr of both ethylene and polyethylene. British Petroleum will retain up to a 49% equity, and 40% will be floated on the Muscat Securities Market. The Oman Oil Co. (OOC) will account for the remainder. A joint-venture fertilizer plant to export annually 1.45 Mt of urea to India and about 315,000 tons of ammonia to other countries is due to begin production in early 2000. The OOC will hold 50% equity in the plant, and two Indian firms will each hold 25% equity.

Although Omani has scaled down its position in the Caspian Pipeline Consortium, the project remains ongoing. Contracts were awarded to build a pipeline system linking the Caspian and Black Seas. The 750-km-long pipeline was expected to carry oil from Azerbaijan, Kazakstan, and Russia, terminating at the port of Novorossiysk on the west coast of the Black Sea. Initial capacity was expected to be 300,000 bbl/d, increasing eventually to 1.5 Mbbl/d.

The Omani Government took a 20% equity position in a 120,000-bbl/d refinery to be constructed in Rayong, Thailand. The new refinery was expected to accept Omani crude for processing.

The Ministry of Petroleum and Minerals had reported proven copper ore reserves at 8 Mt and proven chromite ore reserves at 1.6 Mt. Recoverable petroleum reserves were estimated by the Ministry of Petroleum and Minerals at 5.3 billion barrels. At least an additional 1.5 billion barrels could be recovered through steam soak, polymer and steam flooding, hot-water injection, and (or) electromagnetic heating of the reservoirs. Recoverable reserves of natural gas have nearly tripled in the last 5 years to 780 billion cubic meters, most of which is nonassociated natural gas (Arab Petroleum Research Center, 1997).

Petroleum and natural gas pipelines totaled nearly 3,000 km. The bulk of crude oil production was serviced by the central pipeline running from the Dhiab Field in the south to the Mina al-Fahal export terminal near Muscat.

An agreement was signed with the Kuwait Fund for Arab Economic Development for $20.4 million to help finance an expansion of the Port of Mina Qaboos from 1.6 Mt to 2.6 Mt capacity at an estimated cost of $65 million. A port at Salalah is being developed by the Salalah Port Services Co. a consortium including the Government, Sealand of the United States, and local investors.

Projects augmenting the central electric grid generating capacity and extending the power network were in various stages of implementation. Expansion work at Ghubra, Oman's largest power station, was completed in 1995, including the installation of two additional 125-MW-capacity natural gas turbines.

The Sultanate of Oman had enjoyed a stable economy sustained by petroleum revenues for more than a decade. Improving technology augmented reserves that continued to outpace reservoir withdrawals, affording a substantial economic base for at least the next 20 years at the current rate of production. The development of the nation's natural gas reserves and increasing overseas investments will place Oman in a secure position when its own petroleum reserves are depleted. The LNG project will provide greater economic diversification, enhance trade relations, and provide a large technology transfer and more opportunities for employment for Omani nationals. During the year, a series of key agreements were completed permitting the project to proceed. Buyers for the majority of the plant's output are now guaranteed for at least 25 years. An offshoot of the LNG project includes a world-scale petrochemical complex, a new aluminum plant, a nitrogenous fertilizer plant, a new power station, a new container port, and a free trade zone at Salalah. The budget deficit is scheduled to be eliminated by 2000 under the 1996-2000 Development Plan. Oil earnings averaged more than $19 per barrel in 1996 and $22 in early 1997, compared with the Government's conservative estimate of $15 per barrel as budgeted for 1996. This increase should result in $1.2 billion more in oil revenues than originally budgeted for 1996.

## References Cited

Arab Petroleum Research Center, 1997, Arab Oil & Gas Directory: Arab Petroleum Research Center, Paris, p. 286-310.

Industrial Minerals, 1996, Oman cement's expansion program: Industrial Minerals, no. 348, September, p. 31.

Middle East Economic Digest, 1996a, Oman: Middle East Economic Digest, v. 40, no. 16, April 26, p. 38.

———1996b, Oman: Middle East Economic Digest, V. 40, no. 28, July 19, p. 32.

## Major Sources of Information

Ministry of Petroleum and Minerals
P.O. Box 551
Muscat, Sultanate of Oman
Telephones: (968)-603-333/603-341/603-563
Fax: (968) 696-972

Oman Cement Co.
P.O. Box 3560
Ruwi-Muscat, Sultanate of Oman
Fax: (968) 626-414

Petroleum Development Oman
P.O. Box 81
Muscat, Sultanate of Oman
Telephone: (968) 678-111
Fax: (968) 677-106

Oman Chromite Co.
P.O. Box 1313
Muttrah, Sultanate of Oman
Telephone: (968) 694-564
Fax: (968) 850-865

Oman LNG LLC
P.O. Box 560
Mina al-Fahal 116
Muscat, Sultanate of Oman
Telephone: (968) 675-797
Fax: (968) 675-798

Oman Mining Co.
P.O. Box 758
Muscat, Sultanate of Oman
Telephone: (968) 850-867
Fax: (968) 793-865

TABLE 1

OMAN: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

| Commodity | | 1992 | 1993 | 1994 | 1995 | 1996 e/ |
|---|---|---|---|---|---|---|
| Cement, hydraulic | thousand tons | 970 | 1,000 | 1,200 | 1,177 r/ | 1,260 2/ |
| Chromite, gross weight | | 1,760 | 10,236 | 6,166 | 5,300 e/ | 15,252 2/ |
| Copper: | | | | | | |
| Mine output, Cu content | | 13,600 | 12,000 e/ | 6,500 | -- | -- |
| Metal: | | | | | | |
| Smelter | | 15,000 | 27,700 3/ | 31,200 4/ | 34,200 4/ | 24,663 2/ |
| Refinery | | 16,236 | 20,539 5/ | 24,194 4/ | 33,900 4/ | 24,150 2/ |
| Gas, natural: | | | | | | |
| Gross | million cubic meters | 5,300 | 5,400 | 6,000 e/ | 6,860 r/ e/ | 9,071 2/ |
| Dry | do. | 3,110 | 3,150 | 3,200 e/ | 3,015 | 3,176 2/ |
| Gold | kilograms | 94 | 90 | 137 | 591 r/ | 576 2/ |
| Natural gas liquids e/ | thousand 42-gallon barrels | 2,300 | 2,300 | 2,300 | 2,300 | 2,500 |
| Petroleum: | | | | | | |
| Crude | do. | 270,800 | 283,240 | 293,800 | 310,600 e/ | 322,300 |
| Refinery products: | | | | | | |
| Gasoline | do. | 4,440 | 4,500 | 4,600 e/ | 4,632 r/ | 4,888 2/ |
| Jet fuel | do. | 2,370 | 2,500 | 2,500 e/ | 2,500 | 2,500 |
| Kerosene | do. | 80 | 90 | 90 e/ | 90 | 90 |
| Distillate fuel oil | do. | 4,580 | 4,600 | 4,800 e/ | 4,800 | 4,800 |
| Residual fuel oil | do. | 12,100 | 12,500 | 12,500 e/ | 12,500 | 12,500 |
| Other | do. | 850 | 900 | 900 e/ | 900 | 900 |
| Total | do. | 24,420 | 25,090 | 25,390 e/ | 25,422 r/ | 25,678 |
| Sand and gravel | thousand tons | 6,540 | 7,000 r/ e/ | 8,000 r/ e/ | 9,395 r/ | 9,629 2/ |
| Silver | kilograms | 3,205 | 3,300 | 1,500 r/ e/ | 100 r/ e/ | 97 2/ |
| Stone: | | | | | | |
| Marble | thousand tons | 54 | 76 | 70 | 145 e/ | 150 |
| Other | do. | 1,960 | 1,930 | 2,000 e/ | 2,000 e/ | 3,000 |
| Sulfur e/ | | 40,000 | 40,000 | 40,000 | 35,000 | 30,000 |

e/ Estimated. r/ Revised.

1/ Table includes data available through Nov. 1, 1997.

2/ Reported figure.

3/ Includes 17,800 metric tons of anode as toll/custom output.

4/ Includes toll/custom output.

5/ Includes 12,600 metric tons of cathode as toll/custom output.

## THE MINERAL INDUSTRY OF

# QATAR

### By Bernadette Michalski

Qatar's principal mineral commodity, crude oil, will be overshadowed by natural gas production from the North Field by 2000. The huge natural gas reserves of Qatar's North Field may be the largest nonassociated gas field in the world at more than 7 trillion cubic meters ($m^3$) which should underwrite the Nation's economic prosperity through much of the next century. For the present, Qatar's economy remains largely dependent on the oil industry which accounts for 80% of total exports and about 70% of Government revenues.

The Government encouraged foreign investments. Foreign investors entering into joint ventures with Qatari partners could hold a maximum 49% share of the business. Importers were required by law to have an import license for almost all products, but import licenses were issued only to Qatari citizens. Even in the case of joint ventures, the import license was issued to the Qatari partner. Although wholly foreign-owned firms were allowed to operate in Qatar, they had to have a local sponsor.

The Government accelerated measures to attract foreign and local investors to participate in the economy, particularly in the natural gas industry. The Government, through Qatar General Petroleum Corp. (QGPC), was involved in two major liquefied natural gas (LNG) ventures; both were at Ras Laffan, the nearest landfall to the offshore North Field.

Production of nonfuel minerals such as cement, fertilizer, and steel increased. Cement was produced from domestic and imported clinker. Production in excess of plant design capacity at the steel and fertilizer facilities continued and stemmed from technological improvements made at the plants. Also, the frequency and length of shutdown and maintenance time was reduced significantly to meet demand. *(See table 1.)*

The country's major trading partners are Brazil, the Gulf Cooperation Council (GCC) nations, Japan, the Republic of Korea, the United States, and Western Europe. Qatar imported pelletized iron ore from Bahrain and raw materials for the steel and construction industries from Japan, the United States, and Western Europe. Other imports from the United States included power-generating machinery and equipment, nonferrous metals, such as copper and copper alloys, aluminum semimanufactures, zinc and zinc alloys, vehicles, and heavy machinery. While exports were dominated by crude oil and at yearend included LNG, the Qatar Fertilizer Co. exported 274,000 tons of ammonia and 850,000 tons of urea in 1996 with China and India as the principal markets.

Construction of a 240,000-metric-tons-per-year (t/yr) capacity aluminum smelter is under consideration as a joint venture between Qatar and Norsk Hydro ASA of Norway. The $1 billion[1] smelter's completion is anticipated in 2002. The raw material, alumina, is to be supplied by India.

Qatar Steel Co. Ltd. (QASCO) has produced about 80% above design capacity of 330,000 metric tons (t) since 1989 and continued with production above capacity in 1996. Almost all of its output (90%) was exported, mostly to GCC countries. QASCO remained 70% owned by the Government, with 30% held by two Japanese companies: Kobe Steel (20%) and Tokyo Boeki (10%). Qatar was negotiating with the Japanese firms as to the purchase of their 30% equity in the Qatar Steel Co. QASCO has embarked on a $275 million two-stage expansion program that would increase its capacity to 1.2 million metric tons per year (Mt/yr).

The Qatar Hot Briquetted Iron Co. (Qabico) was established to develop a 2 Mt/yr capacity $400 million hot molded briquetted iron plant by 1999. Qasco holds 31% equity with the Qatar Industrial Manufacturing Co., Qatar Shipping Company, Dover Co., Mitsubishi, Mitsui and Marubeni each taking 10% and the Gulf Investment Co. and the Kuwait National Industrial Co. each acquiring 4.5%. Ore supply contracts for the plant have reportedly been signed with CVRD of Brazil and LKAB of Sweden.

Qatar Fertilizer Co. (QAFCO), the sole producer of fertilizer, was a 75-25 joint venture of Qatar General Petroleum Corp. and Norsk Hydro of Norway, respectively. QAFCO III, a 1,500-metric-tons-per-day (t/d) ammonia and a 2,000-t/d urea plant was on schedule for completion in March 1997. Total annual capacity at the ammonia plant would be raised from 750,000 t to 1.3 Mt, and for the urea plant from 820,000 t to 1.55 Mt. Other components of the project included an ammonia tank farm with an annual capacity of 20,000 t, a 100,000-t urea storage facility, a desalination plant, and a 42-megawatt (MW) powerplant.

Qatar Liquefied Gas Co. (Qatargas) was established in 1984 to develop the North Field for the production of natural gas and condensate and to construct and operate a gas liquefaction plant to convert natural gas into LNG for export. Present equity in Qatargas is QGPC 65%, Total SA of France and Mobil Oil of the United States each 10%, and Marubeni Corp. and Mitsui & Co. of Japan each 7.5%. The first 2-Mt/yr capacity train was commissioned on September 22, 1996, the second in early December, and the third to be commissioned in early 1999. The 25-year supply contract calling for 4 Mt/yr of LNG to Chubu Electric Power Co. of Japan commenced on December 16 with the first shipment (59,000 t) from Ras Laffan arriving at the LNG reception terminal at Kawagoe, Japan, on January 10, 1997.

---

[1] **Where necessary, values have been converted from Qatari riyals (QRls) to U.S. dollars at the rate of QRls3.64=US$1.00 in 1996.**

A second LNG venture, the Ras Laffan LNG Co. (RASGAS) is well underway with loan guarantees partially secured and at least one downstream contract secured. Equity holders are QGPC 66.5%, Mobil 26.5%, Itochu Corp. 4%, and Nissho Iwai Co. 3%. RASGAS is developing a LNG plant at Ras Laffan which will have an initial capacity of 6 Mt/yr with a possible eventual increase to 10 Mt/yr. The plant is scheduled to enter production in July 1999.

Crude oil production increased significantly in 1996, exceeding the Organization of Petroleum Exporting Countries' (OPEC) quota of 378,000 barrels per day (bbl/d) for an average output of about 500,000 bbl/d. Increased output from the Idd Al-Shargi, Al Shaheen, and Durkhan Fields along with the Al-Rayyan Field which came on-stream in the last quarter, accounted for most of the rapid rise in 1996 production. The commissioning of the Al Khaleej Field in early 1997 should raise production capacity to 575,000 bbl/d.

The National Oil Distribution Co., a subsidiary of QGPC, operates the nation's sole refinery. The 63,000 bbl/d capacity Umm Said Refinery was undergoing upgrading, increasing distillation capacity to 80,000 bbl/d.

Proven reserves of crude oil are considered to be between 3.5 and 3.7 billion barrels. In September, an official of QGPC placed reserves at 5 billion barrels. Natural gas reserves are at least 7 billion $m^3$. (Arab Petroleum Research Center, 1997).

Qatar continued to develop its infrastructure. There were 235 kilometers (km) of petroleum and 400 km of natural gas pipelines, running east to west from Doha to Dukhan, and from Umm Said through Umm Bab to Dukhan. Other pipelines also linked offshore fields in the Arabian Gulf to Umm Said. Hydrocarbons were exported from five terminals: Halul Island, which served the offshore fields; Umm Said, which served the onshore fields; Ras Abu Abbud and Abu Hamur, which were terminals for refined products, and the Ras Laffan LNG terminal which was completed in 1996.

Qatar has successfully implemented several major mineral related projects during the year and is projected to meet with further successes in 1997. While the North Field natural gas projects continue to be given top priority, petroleum refining, petrochemical projects, iron and steel projects, electric powerprojects, and desalination programs are presently under development. These industries together with the development of the gasfields to full capacity by 2010 should guarantee Qatar's economic well-being through much of the next century.

## Reference Cited

Arab Petroleum Research Center, 1997 Arab oil and gas directory, Qatar, Paris: Arab Petroleum Research Center, p. 311-342.

## Major Sources of Information

Qatar General Petroleum Corp.
P.O. Box 3212
Doha, Qatar
Telephone: (0974) 491-491
Fax: (0974) 831-125
National Oil Distribution Co.
P.O. Box 50033
Umm Said, Qatar
Telephone: (0974) 776-555
Fax: (0974) 772-880

## TABLE 1
## QATAR: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

| Commodity 2/ | | 1992 | 1993 | 1994 | 1995 | 1996 e/ |
|---|---|---|---|---|---|---|
| Cement, hydraulic | | 544,348 | 544,000 | 469,502 r/ | 475,380 r/ | 500,000 |
| Gas, natural: | | | | | | |
| Gross | million cubic meters | 17,050 | 18,400 | 18,300 r/ | 18,800 r/ | 22,000 |
| Dry | do. | 12,620 | 13,500 | 13,500 r/ | 13,600 r/ | 18,000 |
| Iron and steel, metal: | | | | | | |
| Direct-reduced iron | thousand tons | 567 | 601 | 610 | 622 | 632 3/ |
| Steel, crude | do. | 588 | 620 | 572 | 614 | 626 3/ |
| Semimanufactures: | | | | | | |
| Billet | do. | 588 | 609 | 610 | 606 r/ | 617 3/ |
| Bars | | 570 | 590 | 600 | 601 r/ | 601 3/ |
| Natural gas liquids | thousand 42-gallon barrels | 20,000 | 18,200 | 18,200 | 18,500 e/ | 21,000 |
| Nitrogen: N content of ammonia | | 622,000 | 627,200 | 646,055 r/ | 653,462 r/ | 635,027 3/ |
| Petroleum: | | | | | | |
| Crude: | thousand 42-gallon barrels | 154,000 r/ | 142,000 r/ | 138,200 r/ | 142,300 e/ | 182,000 |
| Refinery products: | | | | | | |
| Gasoline | do. | 3,285 | 3,350 | 4,661 r/ | 4,441 r/ | 4,525 |
| Kerosene | do. | 3,175 | 2,845 | 3,377 r/ | 3,217 r/ | 3,200 |
| Distillate fuel oil | do. | 6,100 | 4,890 | 5,480 r/ | 5,126 r/ | 5,025 |
| Residual fuel oil | do. | 5,840 | 5,730 | 6,278 r/ | 6,064 r/ | 6,000 |
| Other | do. | 2,190 | 1,240 | 1,000 r/ | 900 r/ | 2,000 |
| Total | do. | 20,590 | 18,055 | 20,796 r/ | 19,748 r/ | 20,750 |
| Stone, limestone e/ | thousand tons | 900 | 900 | 900 | 900 | 900 |
| Sulfur e/ | | 60,000 | 60,000 | 61,000 | 61,000 | 61,000 |
| Urea | | 825,900 | 825,000 | 858,000 | 886,000 e/ | 870,000 3/ |

e/ Estimated. r/ Revised.

1/ Table includes data available through Nov. 1, 1997.

2/ In addition to the listed commodities, Qatar also produced clays, gypsum, and sand and gravel for construction purposes.

3/ Reported figure.

## THE MINERAL INDUSTRY OF

# SAUDI ARABIA

### By Bernadette Michalski

The world's largest producer of crude oil, the Kingdom of Saudi Arabia, accounting for 13% of the total world output in 1996, achieved a significant diversity in its mineral industry in recent years through the development of gold mining operations and of value-added cement, fertilizer, petrochemical, and steel manufacturing facilities. Awaiting exploitation are bauxite, iron ore, phosphate, and polymetallic base metal deposits, which are expected to add to this diversity and consequently to reduce reliance on petroleum earnings. The bulk of revenues and export earnings, however, continue to be generated by the hydrocarbon industries, including downstream refining and petrochemicals. Petroleum accounted for more than 75%, or $35.9 billion,[1] of Government revenues in 1996. Economic conditions improved appreciably in 1996; most of the improvement was attributable to the sharp increase in oil prices. Consequently the petroleum sector accounted for more than 37% of the gross domestic product compared with 35% in 1994. The mining sector brought $666 million in profits, most of it in the form of profits to the private sector (E & M J, 1997).

**Government Policies and Programs**

Emphasis was placed on the diversification and expansion of the economic base while securing a more-balanced allocation of resources among the different regions of the Kingdom. The Deputy Ministry for Mineral Resources (DMMR) has enlisted the cooperation of the U.S. Geological Survey and the Bureau de Recherches Géologiques et Minière of France in the mineral exploration and assessment of the mineral resources of the country. The results of more than 30 years of exploration have been made available in open file reports, technical reports, bulletins, annual reports, and geoscience maps. The Government has focused on development of the Kingdom's resources of bauxite, copper, gold, iron ore, phosphate rock, and zinc. The Government continued to encourage private capital to participate in the Kingdom's economic development to the extent of offering low-interest loans to qualified companies.

Preparations were underway for the establishment of the Saudi Arabian Mining Company (Ma'adin). Ma'adin's capitalization is planned at more than $1 billion and will be wholly owned by the State. The company is to spearhead exploration and mining activities in Saudi Arabia on a commercial and profitable basis. It is also to engage in downstream-related industries rather than limiting its scope to the production of raw materials. The company is to study and propose possible changes in mining legislation to encourage further private investment. One of the basic challenges is to provide infrastructure in the remote areas where most mineral deposits are located. One consideration is the development of a national railroad network connecting Dammam with Jubail and Jedda with Dammam. An integrated mining and transportation policy is expected in the near future.

**Environmental Issues**

Saudi Arabia created a ministerial committee to set standards and procedures for environmental protection, such as emission controls and the monitoring of air and water pollution. The committee drew its membership from the 12 ministries. Each ministry carried out its own environmental audit under the guidance of the Central Department on the Environment and the Department of Meteorological Observation and Environment.

**Production**

In 1996, the average production of crude oil, the Kingdom's principal mineral commodity, was 8.2 million barrels per day (Mbbl/d) including the Saudi Arabian share of production from the Divided Zone. *(See table 1.)* Although actual production capacity is 10 Mbbl/d, output has been averaging 8 Mbbl/d in recent years in accordance with the quota assigned by the Organization of Petroleum Exporting Countries (OPEC).

**Trade**

The Kingdom's trade surplus for all goods reached $29 billion, climbing from $22.8 billion in 1995. Exports were predominantly hydrocarbon products and derivatives accounting for 88% of total exports, which were valued at $55.4 billion. Crude oil exports averaged 6.3 Mbbl/d and petroleum product exports averaged 850,000 barrels per day ( bbl/d). During 1996, Europe imported 1.8 Mbbl/d of crude oil and petroleum products, and Japan imported 1.3 Mbbl/d. Petroleum imports by the United States totaled more than 1.4 Mbbl/d, including 114,000 bbl/d of petroleum products, mostly unfinished oils, liquefied petroleum gases, motor gasoline, and petrochemical feedstock. Saudi Arabia remained the leading supplier to the United States, accounting for 15% of U.S. petroleum imports in 1996 (Energy Information Administration, 1997). Annual imports of minerals were valued at about $1.4 billion.

The value of nonoil exports increased rapidly during the past decade. In 1996, they were valued at $6.5 billion rising from about $1 billion in 1983. As more industries come on-stream, this trend was expected to continue.

The Kingdom's total imports were valued at $26 billion in

---

[1] **Where necessary, values have been converted from Saudi riyals (SRls) to U.S.dollars at the rate of SRls3.7450=US$1.00.**

1996. The United States remained the largest supplier to the Kingdom and accounted for 21% of Saudi Arabia's imports. Japan was second with 12% of the market share, followed by the United Kingdom and Germany each at 8% (International Monetary Fund, 1996).

Most imports were subject to customs duties at rates ranging from 12% to 20%. Imports from members of the Gulf Cooperation Council (GCC) were exempted, provided that at least 40% of the value added was effected in GCC countries and at least 51% of the capital of the producing firm was owned by citizens of GCC-member countries.

The monetary authorities and all other residents, including private persons, could freely and without license purchase, hold, and sell gold in any form, at home or abroad. They could also, without license and without payment of any customs duty or tax, trade gold in any form, with the exception of gold of 14 carats or less, the import of which was prohibited.

### Structure of the Mineral Industry

All minerals, including vast petroleum and natural gas reserves, were owned by the Government. Exploitation was predominantly controlled by Government organizations. *(See table 2.)* The government-owned Saudi Aramco was the only company authorized to engage in oil exploration and development.

### Commodity Review

#### *Metals*

**Aluminum.**—Reynolds Metals of the United States was selected to supply technology for and to manage and operate a new aluminum canmaking plant in Dammam. The plant was scheduled to produce up to 1.2 billion beverage cans per year.

The Al-Amoudi Brothers Co. of Saudi Arabia and the Aluminium Processing Co. of Germany formed a joint venture creating the Causi Aluminium Recycling Co. in the Al-Jubayl Industrial Estate. The plant's capacity to recycle scrap and beverage cans ranged from 12,000 to 18,000 metric tons per year (t/yr).

**Bauxite.**—The DMMR continued plans for exploitation of the Az Zabirah bauxite deposit about 470 kilometers (km) northwest of Riyadh. The deposit was part of a Cretaceous paleolaterite that outcropped in three main zones covering a distance of 105 km. Minable reserves were reported by the DMMR at 102 million metric tons (Mt) of essentially monohydrate ores averaging 57.5% aluminum oxide, 5.5% silicon dioxide, and 8% ferric oxide.

**Copper.**—The Alujain Corp. of Saudi Arabia has placed a hold on its plans to develop a large copper deposit in the Arabian Shield about 340 km northeast of Jidin Jabal Sayid. The deposit was defined at 80 Mt grading 1.5% copper. The proposed copper smelter at Madinat Yanbu Al-Sinalyah on the Red Sea coast was also put on hold.

**Ferroalloys.**—The Gulf Ferroalloys Co., owned by GCC investors, brought a ferroalloy complex on-stream in mid-1996 at Al-Jubayl, a location accessible to high-purity quartz and inexpensive energy. The complex has a capacity of 105,000 t/yr of ferrosilicon, ferromanganese, silicomanganese, and silicon. The ferrosilicon production was expected to be exported because domestic needs did not exceed 3,000 t/yr. Ferromanganese, silicomanganese, and silicon metal production was intended for local consumption, principally the steel and aluminum industries in the region.

**Gold.**—Gold recovery continued at the Mahd Adh Dhahab underground mine, 275 km northeast of Jiddah, and at the Sukhaybirat surface mine, about 480 km northwest of Riyadh. Production from Mahd Adh Dhabab exceeded 5 metric tons (t), and production at Sukhaybirat approached 3 t in 1996. As of yearend, proven ore reserves at the open-pit mine were 750,000 t grading 2.2 grams per metric ton (g/t) of gold.

The Saudi Company for Precious Metals, Ltd. (SCPM) is developing a major gold deposit adjacent to the Sukhaybirat open-pit mine involving excavation to the 150-meter level bringing 3.5 Mt of inferred reserves into the proven ore reserve category. This includes 2 Mt grading 2.3 g /t of gold and 1.5 Mt of heap-leach material grading 0.73 g/t of gold. In addition, SCPM has stockpiled 1.75 Mt of material at an average grade of 1.0 g/t of gold, which will be processed in 1998 and 1999 in conjunction with ore mined from the extended excavation. Several other commercially significant gold deposits have been discovered in the Arabian Shield. The Al-Amar Mine is now under development. The Al-Hajar, As-suq, and Khnaiguiyah deposits are awaiting development.

The Dhahab Co. Ltd., a Saudi Arabian/French joint venture, operated a gold refinery at Jiddah.

**Iron and Steel.**—A feasibility study by British Steel Consultants recommended construction of a 2.2- million-metric-tons-per-year (Mt/yr) pelletizing plant to process concentrates from the Wadi Sawawin iron ore deposit 60 km from the Red Sea coast and 900 km north of Jiddah. The iron content of the fine-grained taconite ore body ranged from 42% to 45%. Pilot plant tests produced a concentrate with an iron content of 67.5% at a 75% recovery rate. The method of beneficiation developed for the project requires 1 cubic meter of clean water for every metric ton of ore processed. The basic iron ore agglomeration technology was developed by using the Tilden process pioneered by the U.S. Bureau of Mines in the 1970's. The projected startup date was 1997.

The Saudi Iron and Steel Co. issued a contract for construction of the third-stage expansion of its Al Jubayl complex in April 1996, with completion scheduled in 1999 at which time total production capacity will increase from its present 2.7 Mt/yr to 3.5 Mt/yr of various steel semimanufactures.

**Zinc.**—The Arabian Shield Development Co. of Dallas, Texas, and two Saudi Arabian partners jointly obtained an industrial license to process Al-Masane polymetallic ores. The Al-Masane deposit, in southwestern Saudi Arabia, contains demonstrated reserves of 7.2 Mt averaging 5.33% zinc, 1.44% copper, 1.2 g/t gold, and 43 g/t silver. Output was anticipated to be 58,000 t/yr of zinc concentrates containing 54% zinc, 34,900 t/yr of copper concentrates containing 25% copper, and a total of 22,000 ounces of gold and 800,000 ounces of silver from the copper concentrate and the doré bullion, which is to be produced from the cyanidization plant to be built at the mine site. Financing of 50% of the cost, or $44 million, as an interest-free loan is anticipated from the Saudi Industrial Development Fund. The Arabian Shield Development Co.'s Saudi Arabian partners are to provide $22 million, and a like amount is to be derived from commercial banks in Saudi Arabia and the Gulf area. The remaining financing was expected to be derived from equity offerings.

*Industrial Minerals*

**Cement.**—Production capacity totals about 14 Mt/yr of clinker and 15 Mt/yr of cement from seven manufacturers. New facilities are scheduled to come on-stream in 1997 and 1998, raising total capacity to 19.6 Mt/yr of clinker and 20.9 Mt/yr of cement. Construction activity maintained strength through 1996; cement consuming construction projects are, however, expected to slow in 1997, moving Saudi Arabia into the international cement and clinker export trade (International Cement Review, 1997).

**Fertilizers.**—A reorganization of the Kingdom's fertilizer industry was implemented by the merger of three state-owned companies—the National Chemical Fertilizer Co., the Saudi Arabian Fertilizer Co., and the Al-Jubayl Fertilizer Co. These companies have the combined capacity to produce nearly 4 Mt/yr of fertilizers. The merger was intended to increase efficiency and boost earnings as a part of a general effort to reduce the budget deficit.

Abundant reserves of low-cost feedstocks formed the basis of the Arabian Gulf fertilizer industry. The regional fertilizer producers were poised to become dominant suppliers of nitrogen fertilizers in the international market.

**Phosphate.**—The phosphate rock deposit in Al-Jalamid, about 120 km from Turayf, near the Jordanian border, has proven reserves of 213 Mt of ore averaging 21% diphosphorus pentoxide. The deposit is to be developed by Ma'adin, the proposed state mining company, and a consortium of private companies. Possible participants are the Saudi Binladin Group with Raytheon of the United States, the Al-Murjan Minerals Technology Company with IMC fertilizer of the United States, and Saudi Oger. The beneficiation process was expected to produce 4.5 Mt/yr of phosphate concentrate that will be transported 1,200 km to Al-Jubayl. The original feasibility study proposed using a slurry pipeline to transport the concentrates; a railway system, however, now seems to be favored (Middle East Economic Digest, 1997).

*Mineral Fuels*

**Natural Gas.**—Most of Saudia Arabia's natural gas reserves are associated with petroleum production. The Ghawar Field accounts for more than one-third of the Kingdom's natural gas reserves. There were 64 gas-oil separation plants in the country. The Kingdom's Master Gas System had the capacity to process 45 billion cubic meters of natural gas. This amount was associated with a crude oil production of about 8.2 Mbbl/d. With the completion of an expansion program to bring sustainable crude oil production capacity to 10 Mbbl/d, Saudi Aramco's focus shifted to the expansion of natural-gas-processing installations and distribution networks. Among the major projects under development were the expansion of the Ju'aymah natural gas liquids (NGL) plant capacity by 300,000 bbl/d, construction of a fourth natural-gas-processing plant servicing natural gas extracted from the Khuff reservoir, and the augmentation of the Uthmaniyah natural gas handling capacity. Saudi Aramco is also expanding the three gas processing plants of its master gas system. ABB Lummus Global of the United States should complete the expansion of the Berri plant in 1997 adding 10 million cubic meters per day (Mm$^3$/d) for a total natural gas processing capacity of 30 Mm$^3$/d. Other plants scheduled for makeovers are the Shedgum Plant where gas processing capacity is to be increased to 57 Mm$^3$/d and the Uthmaniyah Plant to 58 Mm$^3$/d.

The production of NGL substantially increased during the past few years with combined output now exceeding 600,000 bbl/d. Of this figure, about 4,800 bbl/d was exported, sustaining Saudi Arabia's position as the world's foremost exporter of NGL.

Saudi Arabia was the largest producer of ammonia and methanol in the Arabian Gulf, the largest methanol exporter, and the third largest ammonia exporter. Natural gas remained an inexpensive feedstock at $0.45 per million British thermal units. Total ammonia production capacity exceeded 1.6 Mt/yr.

Saudi Arabia was one of two Arabian Gulf countries to produce methanol. The Al-Razi plant production capacity of 1,400 t/yr was the largest in the world, and Saudi Arabia's second methanol plant, the Ibn-Sina plant, had a production capacity of 900 t/yr. In addition to marketing methanol from these two domestic facilities, Saudi Basic Industries Corp. (Sabic) also marketed methanol from Bahrain.

**Petrochemicals.**—In 1996, Sabic ranked as the world's third largest producer of petrochemicals, accounting for 22.8 Mt, which represented an increase of about 4% over that of 1995. The principal markets for these products were the Far East and Western Europe. New facilities are scheduled to come on-stream in 1997-98 at Ibn Rushd and Ar Razi, and additional capacity is slated to come on-stream in 1999 at Ibn al-Baytar and Kemya, which should result in an upsurge of petrochemical exports at the close of the decade.

Sabic plans to expand petrochemical production at Saudi Yanbu Petrochemical Company (Yanpet). Upstream expansion will be limited by the availability of feedstock from Saudi Aramco, which transports raw materials through a 1,000-km pipeline from the Arabian Gulf to Yanbu on the Red Sea coast. Saudi Arabia is the world's largest producer of the fuel additive, methyl tertiary butyl ether (MTBE). Affiliates of Sabic had a total production capacity of 2.8 Mt/yr of the gasoline additive in 1996.

The Alujain Corp. has a MTBE plant under construction in Yanbu. The technical services and project management consultant is Bechtel of the United States. The plant is scheduled to have a 850,000-t/yr capacity with production beginning in mid-1999. The plant will be owned by a new company called National Fuel Additives Co. This will be the first private sector MTBE plant in the Kingdom.

**Petroleum.**—Production.—In 1996, Saudi Arabia maintained an average production level of nearly 8.2 Mbbl/d, including output from the Divided Zone. Nearly two-thirds of the output consisted of the higher priced crudes—about 4 Mbbl/d of Arabian Light (34° API gravity), another 900,000 bbl/d of Arabian Extra Light (38° API gravity), and 200,000 bbl/d of Arabian Super Light (50.4° API gravity) to maximize revenues while operating within the production quota allotted by OPEC. Saudi Arabia's quota for the period between 1993 and 1997 was 8 Mbbl/d. The new OPEC quota alotted for 1998 is 8.76 Mbbl/d. Located in the center of the Kingdom, in the Najd region, four new fields came on-stream in late 1994. The fields yielded about 200,000 bbl/d of crude oil designated as Arab Super Light. A fifth field in the region is under development and is expected to come on-stream in late 1997, boosting production from the area to 275,000 bbl/d. Saudi Aramco announced plans to develop the Shuaybah Field in the southeast in the Rub Al Khali. Field production is estimated by the company to be from 500,000 to 600,000 bbl/d of 42° API gravity low-sulfur crude oil. Because of the field's remoteness, development cost is estimated to be $2 billion and completion is anticipated in late 1998 or early 1999.

Refining.—The combined capacity of eight refineries, including the 30,000-bbl/d Al-Khafji refinery in the Divided Zone, was 1,640 Mbbl/d. *(See table 2.)*

Saudi Aramco downsized its ambitious 10-year refinery upgrade and expansion of its Ras Tanura refinery from a planned $12.5 billion upgrade to a more-modest $1.7 billion upgrade and expansion. The revised upgrade plans called for the installation of a 100,000-bbl/d hydrocracker, a 40,000-bbl/d continuous catalytic reformer, a visbreaker, a sulfur recovery unit, a hydrogen plant, and a sour-water-treatment-plant; the upgrades were scheduled to come online in mid-1998. A major upgrade of the Rabigh refinery was undertaken in 1996 at a cost of $1.8 billion. The upgrade entails installation of 12 new units that will enable the refinery to produce greater volumes of gasoline, kerosene, and jet fuel while reducing the volume of heavier products. Saudi Aramco also was engaged in major revamping of its domestic distribution network that involves laying product pipelines from the refineries to the Kingdom's major consumption and export areas.

Saudi Arabia continued to acquire a worldwide network of refining, storage, and distribution facilities. The purchase of 50% equity in Motor Oil Hellas' Corinth refinery in Greece introduced Saudi Aramco to its first downstream presence in Europe, adding to existing interests in the Thalin Refinery in China, in the Sangyong Oil Refining Co. in the Republic of Korea, in Petron in the Philippines, and in Star Enterprise in the United States. Saudi Aramco had a direct interest in downstream refining and market ventures that can process up to 1.4 Mbbl/d of the Kingdom's crude oil. The company's long-term goal was to refine and market one-half of its crude output through companies in which it has an ownership interest. Negotiations for further positions in China, France, India, Indonesia, and Italy continued. Direct investment in foreign refining, marketing, and distribution operations established for Saudi Arabia a guaranteed market for crude oil and provided stability in the face of inevitable market fluctuations.

## Reserves

Saudi Arabia has the world's largest known concentration of oil, representing more than 26% of total proven world reserves. Proven oil reserves are 261.5 billion barrels, including 2.5 billion barrels contained in the Saudi Arabian share of reserves in the Divided Zone. Saudi Arabia is enjoying a reserve-to-production ratio sufficient to last nearly 90 years at current production levels. The bulk of the Kingdom's reserves were contained in a few massive fields in the northeast. These included Ghawar, the world's largest onshore field, with remaining reserves of about 70 billion barrels; Safaniya, the world's largest offshore field with 19 billion barrels; Abqauq, 17 billion barrels; Berri, 11 billion barrels; Manifa, 11 billion barrels; Zuluf, 8 billion barrels; Shuayba, 7 billion barrels; Abu Saafa, 6 billion barrels; and Khursaniya, 3.5 billion barrels. The more-recently discovered fields in the central region of the Kingdom should add from 6 billion to 9 billion barrels to the reserve when appraisal and delineation work is completed (Arab Petroleum Research Center, 1997).

Natural gas reserves were reported by Saudi Aramco to be 5.4 trillion cubic meters including 96 billion cubic meters in the Divided Zone. Most of the Kingdom's reserves were in the form of associated gas contained in the country's oilfields. The giant Ghawar Field was thus the largest source of natural gas and accounted for approximately 35% of the total gas reserves (Arab Petroleum Research Center, 1997).

## Infrastructure

Electric power generation and distribution are conducted under the regional authorities of the Saudi Consolidated Electric Companies operating powerplants with a combined installed capacity of more than 20,000 megawatts (MW). Additional power-generation capacity (2,750 MW) is under the authority of the Saline Water Conversion Corp., which operates seawater-desalination plants. Electric power installed capacity is scheduled to increase from nearly 22,000 MW to about 28,000 MW in 2000 and 60,000 MW in 2020. Currently, 56% of the generating capacity is provided by gas-fired power stations, 42% by steam power stations, and 2% by oil-fired power stations.

Saudi Arabia is the world's largest producer of desalinated water. Current installed capacity exceeds 2 M $m^3$/d. Expansion plans parallel industrial requirements.

Extensive port and harbor facilities served Al-Jubayl on the east coast and Yanbu on the west coast. Al-Jubayl had an industrial port with a 10-km-long causeway for dry and liquid bulk cargo and a commercial port for general cargo. The fertilizer terminal consists of two jetties for loading vessels from

5,000 to 50,000 deadweight tons (dwt). In Yanbu, the 15-km-long King Fahd Industrial Port was the largest oil port on the Red Sea and one of the longest in the world. The oil terminal at Yanbu was expanded to handle 6.6 Mbbl/d and could accommodate tankers from 80,000 to 500,000 dwt.

## Outlook

The Kingdom's business climate had developed favorably since the Gulf War, contributing to a significant construction boom. State and private companies were expanding. Saudi Aramco's expansion program placed the Kingdom in a position to take advantage of the expected growth in world oil demand later in this decade.

Because most of the national income is dependent upon markets outside the Kingdom, the economy remains vulnerable to sudden changes in volume and pattern of worldwide trade in crude and refined petroleum and petrochemicals. Purchasing equities in refining, marketing, and distribution companies in the United States, the Republic of Korea, the Philippines, and Europe eased that vulnerability.

Because Saudi Aramco intends to maintain a maximum sustainable capacity of 10 Mbbl/d, less-profitable fields will be shut down as new producing fields come on-stream. Revenue increases can be anticipated through cutting back on the sale of Arabian heavy in favor of its lighter premium crudes. The level of Saudi Arabian oil production is one of the main factors that will influence world oil prices in 1998, because of the 10% increase in the production quota alotted by OPEC.

The expanding cement industry will require suitable export facilities for handling bulk materials. Saudi Seaports Authority will have to make rapid adjustments to accommodate the additional cement capacity anticipated in 1998-99.

The creation of Ma'adin should allow the mining sector to contribute more efficiently to the Kingdom's economic development. The economy is expected to witness sustained growth during the next 10 years as the proposed mining plans are implemented.

## References Cited

Arab Petroleum Research Center, Arab oil and gas directory—1997: Paris, Arab Petroleum Research Center, p. 343-398.

E & M J, 1997, Chicago, Intertec Publishing, v. 1990, no. 12, p. 32.

Energy Information Administration, 1997, Petroleum supply annual —1996: Energy Information Administration, DOE/EIA 0520 (9708), p. 599.

International Cement Review, 1997, Defying market forces—United Kingdom: Holbrook Ltd.. March, p. 80-86.

International Monetary Fund, 1996, International financial statistics, Dec.

Middle East Economic Digest, 1997, Saudi Arabia: Middle East Economic Digest, v. 41, no. 51, p. 3.

## Major Sources of Information

Ministry of Petroleum and Mineral Resources
Jiddah, Saudi Arabia
Deputy Ministry for Mineral Resources
P.O. Box 345
Jiddah, 21191 Saudi Arabia
Saudi Arabian Oil Co. (Saudi Aramco)
Dhahran 31311, Saudi Arabia
Telephone: [966] (3) 875-5830
Fax: [966] (3) 873-7664
Al-Jubayl Fertilizer Co. (SAMAD)
P.O. Box 10046
Al-Jubayl, Saudi Arabia
Telephone: [966] (3) 341-6488
Fax: [966] (3) 341-5894
National Chemical Fertilizer Co.(IBN AL-BAYTAR)
P.O. Box 10283
Al-Jubayl 31961, Saudi Arabia
Telephone: [966] (3) 341-9988
Fax: [966] (3) 358-7385
Saudi Arabian Basic Industries Corp. (SABIC)
P.O. Box 5101
Riyadh 11422, Saudi Arabia
Telephone: [966] (1) 401-2033
Fax: [966] (1) 401-2045
Saudi Iron and Steel Co. (Hadeed)
P.O. Box 10053
Al-Jubayl 31961, Saudi Arabia
Telephone: [966] (3) 357-1500
Fax: [966] (3) 358-7440
Saudi Company for Precious Metals, Ltd.
P.O. Box 12948
SA-21483 Jiddah, Saudi Arabia
Telephone: [966] (2) 667-2472
Fax: [966] (2) 660-2561

## Publications

Kingdom of Saudi Arabia, Ministry of Finance and National Economy, Central Department of Statistics, Statistical Yearbook, annual.

Saudi Arabian Monetary Agency, Research and Statistics Department, Statistical Summary, annual.

Kingdom of Saudi Arabia, Directorate General of Mineral Resources, Atlas of Industrial MineralsJiddah, 1993.

Kingdom of Saudi Arabia Directorate General of Mineral Resources Mineral Resources of Saudi Arabia Jiddah, 1994.

## TABLE 1
## SAUDI ARABIA: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

| Commodity | | 1992 | 1993 | 1994 | 1995 | 1996 e/ |
|---|---|---|---|---|---|---|
| METALS | | | | | | |
| Ore, mine output: | | | | | | |
| Gross weight 2/ | | 806,000 | 859,353 | 900,000 e/ | 1,400,000 r/ e/ | 1,569,205 3/ |
| Copper content of concentrate and bullion 4/ | | 868 | 925 | 917 | 925 e/ | 834 |
| Gold content of concentrate and bullion 2/ 4/ | kilograms | 5,626 | 7,519 | 7,630 e/ | 8,080 | 8,302 3/ |
| Lead content of concentrate e/ 4/ | | 150 | 50 | 50 | 50 | 50 |
| Silver content of concentrate and bullion 2/ 4/ | kilograms | 17,780 | 17,990 | 16,990 | 16,900 e/ | 16,608 3/ |
| Zinc content of concentrate 4/ | | 525 | 542 | 500 e/ | 500 e/ | 500 |
| Iron and steel: | | | | | | |
| Direct-reduced iron | thousand tons | 1,611 | 2,015 | 2,111 | 2,129 | 2,200 |
| Iron and steel: Metal, steel, crude | do. | 1,823 | 2,318 | 2,411 e/ | 2,451 | 2,500 |
| INDUSTRIAL MINERALS | | | | | | |
| Barite | | -- | -- | 2,000 | 8,000 | 8,000 |
| Caustic soda | | NA | NA | NA | NA | 450,000 |
| Cement, hydraulic | thousand tons | 15,324 | 15,300 | 16,000 | 15,773 r/ | 16,437 |
| Gypsum, crude | | 269,298 | 326,661 | 375,000 | 375,000 e/ | 362,589 |
| Lime e/ | | 150,000 r/ | 150,000 r/ | 160,000 r/ | 175,000 r/ | 180,000 |
| Nitrogen: N content of ammonia | thousand tons | 741 | 1,097 | 1,340 | 1,327 | 1,300 |
| Pozzolana | | NA | NA | NA | NA | 144,000 |
| Salt | | 60,000 r/ | 60,000 r/ | 60,000 | 90,000 | 90,000 |
| Sulfur: Byproduct, hydrocarbons e/ | | 2,370 3/ | 2,400 | 2,300 | 2,400 | 2,400 |
| Urea | | 644 | 650 | 1,300 e/ | 1,500 e/ | 1,800 |
| MINERAL FUELS AND RELATED MATERIALS | | | | | | |
| Gas, natural: 5/ | | | | | | |
| Gross | million cubic meters | 66,100 | 67,300 | 68,000 e/ | 73,900 r/ | 80,000 |
| Dry | do. | 34,000 | 35,900 | 37,700 e/ | 38,030 r/ | 41,340 |
| Natural gas liquids: | | | | | | |
| Propane | thousand 42-gallon barrels | 114,245 | 120,450 | 120,500 e/ | 147,500 r/ e/ | 147,000 |
| Butane | do. | 59,495 | 56,575 | 56,600 e/ | 60,000 r/ e/ | 60,000 |
| Natural gasoline and other | do. | 43,435 | 40,150 | 45,000 e/ | 48,000 r/ e/ | 47,400 |
| Total | do. | 217,175 | 217,175 | 222,100 e/ | 255,500 r/ e/ | 254,400 |
| Petroleum: | | | | | | |
| Crude | do. | 3,100,000 | 2,990,000 | 2,970,000 | 3,004,300 | 2,999,550 |
| Refinery products: | | | | | | |
| Liquefied petroleum gases | do. | 13,505 | 14,965 | 13,000 r/ e/ | 11,315 r/ | 12,000 |
| Gasoline | do. | 88,695 | 89,425 | 92,800 | 85,000 r/ | 85,000 |
| Jet fuel | do. | 21,170 | 25,200 | 30,000 r/ e/ | 21,900 r/ | 22,000 |
| Kerosene | do. | 35,400 | 35,770 | 36,450 e/ | 36,865 r/ | 36,900 |
| Distillate fuel oil | do. | 163,880 | 171,800 | 169,800 | 172,280 r/ | 172,000 |
| Residual fuel oil | do. | 179,550 | 180,700 | 156,640 | 167,200 r/ | 167,000 |
| Unspecified | do. | 64,970 | 62,580 | 73,900 e/ | 73,400 r/ | 73,000 |
| Total 9/ | do. | 567,170 | 580,440 | 572,590 r/ e/ | 567,960 r/ | 567,900 |

e/ Estimated. r/ Revised. NA Not available.

1/ Table includes data available through December 31, 1997.

2/ Production from Mahd Dhahab and Sukhaybirat gold operations.

3/ Reported figure.

4/ Mabd Adh Dhahab produces a bulk flotation concentrate, containing copper, gold, lead, silver, and zinc, and a crude bullion, containing copper, gold, and sliver.

5/ Includes Saudi Arabian one-half share of production in the Saudi Arabia-Kuwait divided zone.

## TABLE 2
## SAUDI ARABIA: STRUCTURE OF THE MINERAL INDUSTRY FOR 1996

(Thousand metric tons unless otherwise specified)

| Commodity | Major operating companies and major equity owners | Location of facilities | Annual capacity |
|---|---|---|---|
| Cement | Saudi Consolidated Cement Co. (Government, majority shareholder) | Ayn Dar, 75 kilometers southwest of Dammam | 1,875 |
| Do. | do. | Al-Hufuf | 1,800 |
| Do. | Arabian Cement Co. Ltd. (Government, 100%) | Rabigh | 1,700 |
| Do. | Southern Province Cement Co. (Government, 100%) | Suq al-Ahad, 10 kilometers northeast of Jizan | 2,500 |
| Do. | Yanbu Cement Co. (Government, 100%) | Yanbu | 1,300 |
| Do. | Yamama Cement Co. (Government, 100%) | Riyadh | 3,000 |
| Do. | Qasim Cement Co. (Government, 100%) | Buraydah | 1,400 |
| Ferroalloys | Gulf Ferroalloys Co. (Sabayek) (United Gulf Industries Corp., 26%; Sabic, 15%; Demetal Aussenhandelsgesellschaft, 7%; remainder owned by Arab investors and financial institutions) | Al-Jubayl | 105 |
| Fertilizer: | | | |
| Urea | Al-Jubayl Fertilizer Co. (Samad) (Sabic, 50%; Taiwan Fertilizer Corp., 50%) | do. | 632 |
| Ammonia | do. | do. | 300 |
| Urea | National Chemical Fertilizer Co. (Ibn al-Baytar) (Sabic, 50%; Safco, 50 %) | do. | 500 |
| Granular urea | do. | do. | 500 |
| Ammonia, liquid | do. | do. | 500 |
| NPK | do. | do. | 500 |
| TSP | do. | do. | 200 |
| DAP | do. | do. | 100 |
| Liquid fertilizer | do. | do. | 10 |
| Urea | Saudi Arabian Fertilizer Co. (Safco) (Sabic, 41%; Saudi Arabian private interests, 59%) | Dammam | 330 |
| Ammonia | do. | do. | 300 |
| Sulfuric acid | do. | do. | 100 |
| Melamine | do. | do. | 20 |
| Ammonia | do. | Al-Jubayl | 500 |
| Granular urea | do. | do. | 600 |
| Gold: | | | |
| Ore | General Organization for Petroleum and Mineral Resources (Petromin) (Government, 100%) | Mahd Adh Dhahab, 270 kilometers northeast of Jiddah | 180 |
| Metal kilograms | | | 5,000 |
| Ore | The Saudi Company for Precious Metals (Petromin, 50%; Boliden International Mining, 50%) | Sukhaybirat, 480 kilometers northwest of Riyadh | 700 |
| Metal kilograms | | | 2,800 |
| Natural gas million cubic meters | Saudi Aramco (Government, 100%) | All oilfields, Eastern Province | 35,000 |
| Do. do. | do. | Khuff Zone, Eastern Province | 20,150 |
| Do. do. | do. | Abqaiq Gas Cap, Eastern Province | 4,600 |
| Natural gas liquids 1/ million barrels | do. | Shedgum, 150 kilometers southwest of Dammam | 60 |
| Do. do. | do. | Uthmaniya, 30 kilometers west of Al Hufuf | 120 |
| Do. do. | do. | Berri, 15 kilometers north of Al-Jubayl | 20 |
| Do. do. | do. | Ju'aymah, 33 kilometers northwest of Ras Tanura | 110 |
| Do. do. | do. | Yanbu | 110 |
| Petrochemicals: | | | |
| Ethylene | Saudi Petrochemical Co. (Sadaf) (Sabic, 50%; Pecten Saudi Arabia, 50%) | Al-Jubayl | 970 |
| Ethylene dichloride | do. | do. | 560 |
| Styrene | do. | do. | 360 |
| Industrial ethanol | do. | do. | 300 |
| Methyl-tertiary-butyl-ether / Ethyl-tertiary-butyl-ether | do. | do. | 700 |
| Caustic soda | do. | do. | 450 |
| Methanol | National Methanol Co. (Ibn Sina) (Sabic, 50%; Celanese Arabian, 25%; Texas Eastern Arabian, 25%) | do. | 900 |
| Methyl-tertiary-butyl-ether | do. | do. | 700 |

See footnotes at end of table.

TABLE 2--Continued
SAUDI ARABIA: STRUCTURE OF THE MINERAL INDUSTRY FOR 1996

(Thousand metric tons unless otherwise specified)

| Commodity | | Major operating companies and major equity owners | Location of facilities | Annual capacity |
|---|---|---|---|---|
| Petrochemicals--continued: | | | | |
| Methanol | | Saudi Methanol Co. (Al-Razi) (Sabic, 50%; Japan Saudi Arabia Methanol Co., 50%) | do. | 1,400 |
| Ethylene glycol | | Eastern Petrochemical Co. (Sharq) (Sabic, 50%; Saudi Petroleum Development Corp., 50%) | Al-Jubayl | 450 |
| LLD Polyethylene | | do. | do. | 660 |
| Ethylene | | Arabian Petrochemical Co. (Sabic, 100%) | do. | 1,150 |
| Polystyrene | | do. | do. | 135 |
| Propylene | | do. | do. | 300 |
| Butadiene | | do. | do. | 100 |
| Benzene | | do. | do. | 70 |
| Methyl-tertiary-butyl-ether | | Saudi European Petrochemical Co. (Ibn Zahr) (Sabic, 70%; Ecofuel, 10%; Neste Oy, 10%; Arab Petroleum Investments Corp., 10%) | do. | 1,400 |
| Polypropylene | | do. | do. | 800 |
| Petroleum, crude | million barrels | Saudi Aramco (Government, 100%) | Eastern Province, Najd Region, and offshore | 3,500 |
| Do. | do. | Arabian Oil Co., (AOC) (Japan Petroleum Trading Co., 80%; Kuwait, 10%; Saudi Arabia, 10%) | Khafji 2/ | 110 |
| Do. | do. | do. | Al Hout 2/ | 10 |
| Do. | do. | Saudi Arabian Texaco | Wafra, South Fawaris, and South Umm Gudair 2/ | 50 |
| Petroleum products | | Saudi Aramco (Government, 100%) | Ras Tanura | 97 |
| Do | do. | Rabigh Petroleum Refining Co. (Saudi Aramco, 50%; Petrola, 50%) | Rabigh | 119 |
| Do. | do. | Jubail Petroleum Refining Co. (Saudi Aramco, 50%; Shell, 50%) | Al-Jubayl | 113 |
| Do. | do. | Yanbu Petroleum Refining Co. (Saudi Aramco, 50%; Mobil, 50%) | Yanbu | 110 |
| Do. | do. | Saudi Aramco Government, 100%) | do. | 69 |
| Do. | do. | Jiddah Oil Refinery Co. (Saudi Aramco) (Government, 100%) | Jiddah | 38 |
| Do. | do. | Riyadh Oil Refinery Co. (Saudi Aramco) | Riyadh | 50 |
| Do. | do. | Arabian Oil Co. (Japan Petroleum Trading Co., 80%; Kuwait, 10%; Saudi Arabia, 10%) | Al-Khafji | 11 |
| Steel | | Saudi Iron and Steel Co. (Hadeed) (Sabic, 95%) | Al-Jubayl | 2,400 |
| Do. | | Jiddah Steel Rolling Mill (Sulb) (Government, 100%) | Jiddah | 245 |
| Titanium dioxide | | The National Titanium Dioxide Co. (Cristal) (Shairco for Trading and Contracting, 25%; National Industrialization Co., 24%; Gulf Investment Corp., 24%; Kerr-McGee Chemical Corp., 25%; private individuals, 2%) | Yanbu | 52 |

1/ Natural gas is pumped through the Master Gas System to processing plants at Berri, Shedgum, and Uthmaniya where natural gas liquids are separated and sent by pipeline to fractionation plants at Ju'aymah and Yanbu.

2/ Divided zone where production is shared between Saudi Arabia and Kuwait.

## THE MINERAL INDUSTRY OF

# SYRIA

### By Bernadette Michalski

Hydrocarbons dominate Syria's mineral industry, particularly the development of nonassociated natural gas deposits in the north and northeast and the development of domestic reservoirs containing light, low-sulfur crude oils providing a higher-priced export crude than traditionally available in Syria. Other significant mineral industries include gypsum and phosphate rock mining, the manufacture of fertilizers and cement, and the manufacture of steel from domestic and imported scrap. The Nation's gross domestic product (GDP) was approximately $14,000 million.[1] Mining and manufacturing accounted for about 14% of the GDP (Middle East Economic Digest, 1996).

Crude oil production averaged 604,000 barrels per day (bbl/d) in 1996. The Al-Furat Petroleum Co., a joint venture between Syrian Petroleum Co., Royal Dutch/Shell, and Deminex, is the country's largest producer with 32 fields in production yielding a total of 390,000 bbl/d of Syrian Light crude oil. The Syrian Petroleum Co. produces 150,000 bbl/d of heavy Suwaidiyah crude oil, and the Deir Es-Zor Petroleum Co. produces about 60,000 bbl/d of light crude oil. Details of Syrian mineral production are shown in table 1.

Exports totaled $4 billion in value, of which approximately $2.6 billion was derived from petroleum. Crude oil export prices improved over 1995. Suwaidiyah (24° API) crude oil averaged $17.74 per barrel in 1996 compared with $14.92 per barrel in 1995. Syrian Light (36.4° API) crude oil averaged $20.54 per barrel in 1996 compared with $16.70 per barrel in 1995.

Exports of Syria's other significant mineral product, phosphate rock, was reported at more than 1 million metric tons (Mt) in 1996, most of which was destined for Europe.

Syria had a state socialist economic system with a growing and vigorous private sector. However, the mineral industry remained owned and controlled by the Government. All mining, processing, and distribution companies were Government-operated firms. Hydrocarbon exploration concessions, however, have been granted to foreign companies on behalf of the Syrian Government.

The construction of an integrated iron and steel plant at Al-Zara near Hamah in east-central Syria was proposed. The plant was expected to include an 800,000-metric ton per year (t/yr) capacity U.S. Midrex direct reduction unit. Plant construction would also include two electric arc furnaces capable of producing 770,000 t/yr of liquid steel and two ladle furnaces for refining the liquid steel. The cost was projected at $750 million.

The Syrian Saudi Co. for Cement was formed in 1995 with 42% equity provided by a Saudi Arabian private business group, 14% provided by the Syrian public sector company, the General Establishment for Cement, and 44% as public offering. Other cement producers are the Syrian Co. for Cement, the Rastan Cement Co., and the Adra Cement Co. Each of these companies were undergoing a million ton expansion program.

Syria's fertilizer manufacturing industry was centered around Homs. There were three plants in operation—two produce nitrogenous fertilizers and the third produces phosphate fertilizers. A second phosphate plant was to be developed near Palmyra. This proposed 500,000 t/yr capacity triple superphosphate plant has undergone considerable delays.

Natural gas production is about to rise substantially as a result of the expansion of processing facilities and the development of five nonassociated gasfields in the Palmyra region. Three of these fields were in production by the close of 1996 and the two remaining fields are expected to enter production in 1997 and 1998. As a result, Syria's dry natural gas production should rise to about 5.8 billion cubic meters (m$^3$) by 2000. Consumption was expected to rise rapidly near the close of this decade, eventually accounting for 30% of the total annual energy consumption compared with about 10% of annual energy consumption in 1996. Several projects were underway, including the conversion of two power stations to natural gas fuel, the Baniyas with a 680-megawatt (MW) capacity and the Mardikh with a 630-MW capacity, and the construction of a gas-fueled power station at Tishrin with a 400-MW capacity. The later project was granted partial financing of $89.4 million by the Kuwait Fund for Arab Economic Development. Syria was also investigating the possibility of piping natural gas to Lebanon and Turkey.

The Al-Furat Petroleum Co. development plans included construction of a natural gas gathering system encompassing the Umar, North Umar, Sharifah, Ash Shajar, Shahil, Al Isba, and Tanak Fields.

Syrian refining policy was to operate its two refineries at full capacity to maximize the production of middle distillates; however, this policy resulted in large surpluses of fuel oil and diesel oil, most of which was exported to Cyprus and Lebanon, while domestic consumption required the import of about 5 million barrels of middle distillates annually. Studies were being evaluated for the overhaul and conversion of the Homs and Baniyas refineries with the objective of producing a higher proportion of light products.

Proven recoverable natural gas reserves were 234.5 billion cubic meters as of January 1, 1997. About 55% is nonassociated gas, 25% is cap gas, and the remaining 20% is associated gas. Recoverable petroleum reserves are 2.5 billion barrels. Syria's known hydrocarbon reserves are concentrated in seven major fields, the largest of which was Suwaydiyah in the extreme northeast section of the country. Proven reserves of this field alone were reported at 1 billion barrels of liquid hydrocarbons and 5.6 billion cubic meters of natural gas.

---

[1] Where necessary, values have been converted from Syrian pounds (£Syr) to U.S. dollars at the rate of £Syr11.2=$1.00.

Railway transportation was available in northern and western Syria servicing the major cities and the three principal ports of Baniyas, Latakia, and Tartus. The existing hydrocarbon pipelines include the Iraq Petroleum Co. (IPC) pipeline traversing Syria from east to west. The pipeline had been closed for Iraqi use since 1982; however, sections of the pipeline were converted to domestic use. More than 100 kilometers (km) of the IPC pipeline was used for natural gas transmission forming part of the 377-km pipeline from the Jubaisseh gas processing plant to the fertilizer complex and refinery in Homs. Another section of the IPC line transported crude oil to the Homs refinery from the Al-Thayyim, Al Ashara, and Al-Ward Fields, which were connected by spur lines to the main pipeline. With the onset of production, two spur lines were constructed connecting the Al-Thayyim Field along with its smaller satellite fields and the Umar Field to the IPC pipeline.

Installed power generation capacity was 3,280 MW, with thermal power stations accounting for two-thirds and hydroelectric powerplants accounting for the remainder.

Syria's posture during the Gulf crisis ended years of isolation from the Gulf States, gaining the Government substantial financial resources to undertake several infrastructure rehabilitation projects. The passage of less restrictive investment laws made Syria one of the more active business locations in the Middle East.

The discovery of nonassociated natural gasfields and the increased utilization of associated natural gas was expected to reduce the demand for fuel oil and thus increase refined product export potential. The $600 million refurbishing of the two petroleum refining facilities should bring the refining industry more in concert with domestic requirements.

Syria planned to take advantage of the growing availability of natural gas feedstock and its indigenous reserves of phosphate by further developing its fertilizer industry.

### Reference Cited

Middle East Economic Digest, 1996, Oman: Middle East Economic Digest, v. 41, no. 6, p. 28.

### Major Sources Of Information

Banias Refining Co.
P.O. Box 26
Banias, Syria
Telephone: [963] 43 238/307
General Company of Homs Refinery
P.O. Box 352
Homs, Syria
Telephone: [963] 31 22771/22768
Fax: [963] 31 20478
General Company for Phosphate and Mines
Palmyra Road, P.O. Box 288
Homs, Syria
Telephone: [963] 31 20405

## TABLE 1
## SYRIA: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

| Commodity | | 1992 | 1993 | 1994 | 1995 | 1996 e/ |
|---|---|---|---|---|---|---|
| Cement, hydraulic | thousand tons | 3,700 | 4,500 | 5,000 | 4,463 r/ | 5,000 |
| Gas, natural: e/ | | | | | | |
| Gross | million cubic meters | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 |
| Dry | do. | 2,800 | 2,800 | 2,800 | 2,900 | 3,000 |
| Gypsum | | 234,432 | 299,812 | 301,600 | 335,683 r/ | 325,000 |
| Iron and steel, steel, crude e/ | | 70,000 | 70,000 | 70,000 | 70,000 | 70,000 |
| Natural gas liquids e/ | thousand 42-gallon barrels | 1,800 2/ | 1,800 | 1,800 | 1,800 | 1,800 |
| Nitrogen: | | | | | | |
| N content of ammonia | | 80,500 | 66,700 | 67,000 | 29,577 r/ | 30,000 |
| Urea | | 43,700 | 75,000 | 75,000 e/ | 62,435 r/ | 65,000 |
| Petroleum: | | | | | | |
| Crude | | 175,600 | 208,000 | 211,335 | 222,650 | 220,500 |
| Refinery products: | | | | | | |
| Liquefied petroleum gas | thousand 42-gallon barrels | 1,800 | 1,800 | 2,000 r/ | 2,100 r/ | 2,122 2/ |
| Gasoline | do. | 10,900 | 9,800 | 11,100 r/ | 11,907 r/ | 11,406 2/ |
| Naphtha | do. | 5,000 | 5,000 | 3,000 r/ | 1,676 r/ | 1,685 2/ |
| Jet fuel | do. | 4,500 | 4,500 | 3,000 r/ | 1,753 r/ | 1,728 2/ |
| Kerosene | do. | 1,400 | 1,600 | 1,400 r/ | 1,484 r/ | 1,491 2/ |
| Distillate fuel oil | do. | 27,400 | 25,000 | 27,000 | 29,951 r/ | 30,078 2/ |
| Residual fuel oil | do. | 34,700 | 35,000 | 35,000 r/ | 34,891 r/ | 35,038 2/ |
| Asphalt | do. | 1,400 | 1,400 | 1,600 r/ | 1,900 r/ | 1,916 2/ |
| Other | do. | 1,800 | 1,800 | 1,800 e/ | 1,800 e/ | 1,900 2/ |
| Total | do. | 88,900 | 85,900 | 85,900 r/ | 87,462 r/ | 87,364 2/ |
| Phosphate rock: | | | | | | |
| Gross weight | thousand tons | 1,270 | 931 | 1,203 | 1,551 | 2,000 |
| $P_2O_5$ content e/ | do. | 395 | 286 | 371 | 477 2/ | 615 |
| Salt e/ | | 84,000 | 113,000 | 127,000 | 111,000 2/ | 112,000 |
| Stone, sand and gravel: e/ | | | | | | |
| Stone, dimension, marble | cubic meters | 18,000 | 18,000 | 18,000 | 18,000 | 18,000 |
| Sand and gravel | thousand tons | 4,095 | 4,200 | 4,200 | 4,200 | 4,200 |
| Sulfur, byproduct of petroleum and natural gas e/ | | 10,000 r/ | 10,000 r/ | 10,000 r/ | 9,824 r/ | 10,000 |

e/ Estimated. r/ Revised.

1/ Table includes data available through Oct. 15, 1997.

2/ Reported figure.

## THE MINERAL INDUSTRY OF

# TURKEY

### By Philip M. Mobbs

In general, the diverse mineral industry of Turkey, showed higher output levels in 1996 compared with those in 1995. The nation's economic crisis continued owing to a combination of factors, such as public sector debt, rapid devaluation of the Turkish lira, the new Government and associated high levels of political uncertainty, inflation, and unemployment (Bodgener, 1997; Butter, Ash, and Bodgener, 1997). The primary mineral sector's contribution to the economy traditionally has been slightly more than 1% of the gross domestic product (GDP). It was estimated that value-added secondary mineral commodities, including refined petroleum products, steel, cement, glass, and certain inorganic chemicals, accounted for about 70% of the value of the nation's manufacturing output. Total (primary plus secondary) mineral industry revenues were estimated to be about 15% of GDP.

The geology of Turkey is extremely complex and is reflected in the diversity of its mineral deposits. Best known for its industrial minerals, Turkey was a major producer of barite, boron minerals, celestite (strontium), emery, feldspar, limestone, magnesite, marble, perlite, and pumice. The country continued to be a major world producer of refined borates and related chemicals, cement, ceramics, and glass. A wide variety of primary metallic minerals was produced as well, but output generally was not considered large to be by world standards. Chromite was the most significant metallic mineral in this sector. Turkey was a significant producer of ferrochromium and of steel. Capacity expansion projects continued at many secondary mineral production facilities. Most mineral exploration in Turkey by international companies was for gold, copper, and zinc.

## Government Policies and Programs

The Turkish economy was burdened by high inflation that had reached 80% on an annual basis by the end of 1995 and continued at the same rate through 1996 (Barham, 1997b). The Government was a major player in most sectors of the Turkish minerals industry through various parastatal (state-owned) industrial corporations, banks, and shareholdings in a number of private companies. The private sector component has grown, especially since the passage of Mining Law No. 3213 in 1985. Hydrocarbon activities were regulated under Law No. 6326 of 1952, Law No. 6556 of 1955, Law No. 6987 of 1957, Law No. 1702 of 1973, and Law No. 2808 of 1983.

Many parastatal corporations have been maintained over the years through high levels of Government borrowing and spending. The Government continued the divestment of its minerals sector holdings to both domestic and foreign investors. Privatization of the general minerals group, Etibank Genel Müdürlüğü, was proposed. Several local and international companies were reviewing lignite and powerplant operations slated for privitization in 1997. Additionally, the privatization of most of the state's petroleum refineries and its remaining cement plants were under negotiation. General aspects of and some specific sales within the overall privatization program have been delayed and/or thwarted by legal challenges from trade union and political entities; these delays are anticipated to continue.

## Environmental Issues

Rapid growth of industry and increasing urbanization of the population have led to increased awareness of and emphasis on environmental issues. A major issue was the use of lignite for domestic heating and for thermal powerplants that provide more than 50% of the country's electricity. For several years, imported natural gas and liquefied natural gas (LNG) has been piped to the Ankara and the İstanbul metropolitan areas where it has replaced lignite for domestic heating, thereby greatly reducing wintertime air pollution. The gas pipeline network was being extended to other cities. Environmental considerations were affecting the Government's plans to address the growing electricity shortages in the country through the construction of new powerplants.

Environmental issues have become a factor in Turkey's foreign relations. Proposed petroleum development in Kazakstan and other landlocked Turkic republics risk oil spills or other shipping hazards if crude petroleum is shipped by supertankers via the Black Sea and the narrow Bosphorus and Dardanelles Straits. As an alternative, Turkey began construction of a 1,625-kilometer (km) pipeline to Yumurtalık on the Mediterranean.

Local opposition to the development of gold mines near the Aegean coast continued. The controversy centered the use of sodium cyanide in heap-leaching extraction methods, and the potential adverse impact on the tourist industry if cyanide were to leak into the streams and aquifers.

## Production

As shown in table 1, Turkey produced a wide variety of mineral commodities. For most metallic commodities, output levels in 1996 were about the same or higher than those in 1995. Chromite was a notable exception—production declined owing, in part, to reduced international demand. Etibank expanded its boron production in 1996, and the country's cement and magnesite output also increased. Few significant production increases in the diverse industrial mineral sector were projected for the year. Data traditionally have been incomplete for many industrial minerals owing to either output being kept proprietary or the minerals being unreported raw materials for reported finished products, such as cement. In the energy mineral sector, hard coal production rebounded, and lignite production again posted an increase.

## Trade

Turkey had a well-developed international mineral trade. Turkey was a major exporter of steel and ferrochromium and exported limited quantities of chromite, copper, and zinc ores, and refined metals. In contrast with metallics, Turkey exported a wide variety of industrial minerals and derived chemicals, however, the value of which dropped slightly in 1996 to $542 million compared with $563 million in 1995 (Öktem, 1997). The country's boron, cement, glass, and ceramics exports were among the world's highest. Turkey's mineral imports were dominated in value by crude and refined mineral fuels, as well as a variety of metallic ores, steel, and other smelted and refined metals.

In July, the Government signed a free trade agreement with the European Coal and Steel Community. The agreement effectively eliminated 95% of the customs duties on steel products between Turkey and the European Union.

## Structure of the Mineral Industry

Traditionally, several sectors of the Turkish minerals industry have been dominated by large parastatals. (*See table 2.*) The Government continued its major privatization program. Private companies have become the dominant producers of a number of commodities, notably, chromite, several industrial minerals, cement, and steel. The mining sector has been estimated to comprise between 750 and 800 mining "establishments," a term roughly equivalent to "company" or "company division." These owned and/or operated about 3,000 mines. Most of the mines in the public and private sectors were small by world standards.

Among the state-owned minerals corporations, the various subsidiaries of Etibank dominated or produced the country's entire output of aluminum, blister copper, boron minerals and chemicals, ferrochromium, and refined zinc. Etibank remained the largest individual chromite producer in Turkey (about 21% of the total in 1996). Turkish hard coal was mined by Türkiye Taşkömürü Kurumu Genel Müdürlüğü, and almost 90% of Turkey's total lignite output was accounted for by Türkiye Komur İşletmeleri Kumumu. About 78% of Turkey's total output of crude petroleum and all its natural gas were produced by Türkiye Petrolleri Anonim Ortaklığı (TPAO) and its subsidiaries. The pipeline company, Boru Hatları ile Petrol Taşıma A.Ş. (Botas), a subsidiary of TPAO until 1995, controlled virtually all the pipeline transport of mineral fuels. Türkiye Petrol Rafinerileri A.Ş. was by far the largest oil refiner in the country. Until recently, cement production was dominated by the parastatal Türkiye Çimento ve Toprak Sanayii T.A.Ş., but privatization has significantly reduced its sectoral share.

Maden Tetkik ve Arama Genel Müdürlüğü (MTA) was the state agency responsible for geologic exploration and research in Turkey.

## Commodity Review

### *Metals*

**Aluminum.**—Plans to expand Etibank's Seydisehir aluminum smelter from 60,000-metric- ton-per-year (t/yr) capacity to 100,000-t/yr capacity were revived in 1996. A prebake anode system was proposed to replace the existing Soderberg anode system.

**Copper.**—Karadeniz Bakır İşletmeleri A.Ş. (KBİ), a subsidiary of Etibank, remained Turkey's largest producer of copper ore and concentrates and was the only producer of blister copper. Copper concentrate feed for KBİ's Samsun smelter came mainly from the company's mines and concentrators in the Murgul District near Artvin. Pyrite output from the KBİ mines and from those directly operated by Etibank contains up to 0.7% copper. The pyrite was used primarily to produce sulfuric acid for Turkish fertilizer manufacturers.

Inmet Mining Corp. of Canada wrote down as a loss its $113 million[1] investment in the recently opened Çayeli copper-zinc underground mine as an unrecoverable investment (Mining Journal, 1996). The metallurgical complexity of the ore resulted in lower-than-planned recoveries. Because of the financial difficulties, capital expenditures at the mine were temporarily suspended in October, and ore output was increased. The mine produced separate concentrates of copper and zinc, which were exported.

**Gold and Silver.**—In recent years, Turkey's precious metals output has been as credits in base-metal (particularly copper) refinery slimes and/or smelted metals exported to Europe plus silver mined at one site. Most Turkish copper ores grade 1 to 2 grams per metric ton of gold along with more-variable silver.

Three gold properties were pending development into mines. All three projects were facing strong, organized, local opposition to the proposed use of sodium cyanide for gold extraction. The Ovacık (Dikili) gold deposit, about 12 km west-southwest of Bergama, was held by Eurogold Madencilik Ticaret ve Ltd. A.Ş., a joint venture of Mine Or SA of France (66.7%) and Inmet (33.3%). Eurogold began construction after receiving final Government approval for the Ovacık Mine in March 1996. The Küçükdere deposit, about 10 km southeast of Edremit, was owned by Tüprag Metal Madencilik Ticaret ve Ltd. Şti., formerly a subsidiary of Gencor Ltd. of South Africa that was acquired by Eldorado Gold Corp. of Canada. Tüprag also held the Kaymaz property, about 145 km west-southwest of Ankara.

**Lead and Zinc.**—The Government sold Etibank's interest in Cinkur Kurşan Metal Sanyii A.Ş. in June 1996. The Cinkur refinery was acquired by Kayseri Maden Metal ve Ticaret A.Ş., a consortium of Mineral Export Co. of Iran (55%), Isko Ltd. of Canada (10%), Ekin Madencilik of Turkey (5%), S.A. Hassan of Iran (5%), Masoud Shamoradi Co. of Iran (5%), and Saradari Macad Madani Co. of Iran (5%) (Metal Bulletin, 1996; Our Turkish Correspondent, 1996). The new owners reportedly were refurbishing the zinc operation, increased zinc production, and proposed to begin refining lead in 1997 (Metal Bulletin, 1997).

---

[1] Values have been converted from Canadian dollars to U.S. dollars at the 1996 yearend rate of C$1.37 = US$1.00.

**Steel.**—Turkish total crude steel production reportedly increased in 1996 to 13.4 million metric tons (Mt) despite declining demand. The Ereğli Demir ve Çelik Fabrikaları T.A.Ş. (Erdemir) was the sole flat products producer. Erdemir increased its production capacity to 3 Mt and initiated a feasibility study concerning an expansion of capacity to 4 Mt per year. In December, the Government's Privatization Administration proposed a partial divestment of the state's interest in Erdemir. Karabük Demir ve Çelik A.S. completed an overhaul of its three blast furnaces during the year.

Turkish scrap buyers were significant importers of Ukrainian scrap metal during 1996, although many private mini-mills had curtailed production operations owing to weak international demand.

### *Industrial Minerals*

Etibank increased run-of-mine boron production to 2.4 Mt in 1996 compared with 1.8 Mt produced in 1995. The company anticipated a similar increase in 1997. Turkey produces almost 50% of the world's boron. A 120,000-t/yr magnesite-washing plant was built near Eskişehir by Comag Continental Madencilik Sanayii Ticaret A.Ş. Persa Perlit Türevleri Sanayi ve Ticaret Ltd. Şti. began perlite mining operations at Biga, near Çanakkale. Silver & Baryte Mining Co. S.A. of Greece acquired 49% of Pabalk Perlite Sanayi A.Ş. FMC Corp. and U.S. Borax of the United States reintroduced a proposal to develop the Beyapzarı trona deposit, approximately 100 km northwest of Ankara. MTA had estimated Beyapzarı reserves to be 233 Mt (Erseçen, 1989, p. 80).

Turkey was one of Europe's leading cement producers with production exceeding 35 Mt in 1996. Akçansa became the country's largest cement company with the merger of Cimenteries CBR S.A.'s Çanakkale Çimento Sanayi A.Ş. and Sabanci Group's Akçimento Ticaret A.Ş. Postprivatization industry consolidation resulted in Cimenteries CBR-Sabanci Holdings Group, Rumeli Çimento Sanayi ve Tic. A.Ş., Oyak, Lafarge Coppée, Set Group Holding, Batı Anadoulu Cimento Sanayii, and the Vicat Co. accounting for 75% of the nation's cement production.

### *Mineral Fuels*

The Turkish Government has been promoting the consumption of natural gas as a clean-burning substitute for lignite. Declining gas production and reserves were inadequate to meet current demand, estimated to be from 6 billion to 8 billion cubic meters per year of natural gas (Middle East Economic Digest, 1995). For several years, Turkey has imported about 6 billion cubic meters per year of natural gas from Russia via a pipeline through Bulgaria and the Ukraine, but the amount of gas supplied by this route was considered to be insufficient to meet long-term demand. Natural gas demand was expected to increase significantly as proposed gas-fired powerplants become operational. A number of new pipeline scenarios were being discussed to bring Russian, Iranian, and Central Eurasian natural gas across the eastern frontier of Turkey. Turkey was importing LNG from Algeria and Australia via the 6-billion-cubic-meter-per-year-capacity LNG storage and regasification plant at Marmaraereğlisi. Botas was contracted to import about 1 billion cubic meters equivalent per year of LNG from Nigeria beginning in 1999. In August 1996, Botas agreed to buy 190 billion cubic meters of natural gas from Iran over a period of 23 years. Delivery of the gas was not expected to begin for several years. In the interim, Botas contracted to acquire 3 billion cubic meters per year of natural gas from Turkmenistan. During November, Botas agreed to import LNG volumes equivalent to 10 billion cubic meters per year of natural gas from Egypt and 1 billion cubic meters per year of natural gas from Qatar beginning in 1998 or 1999. During December 1996, Botas contracted for an additional 1.4 billion cubic meters per year of natural gas from Yemen and was negotiating to increase Russian gas imports.

TPAO accounted for about 78% of domestic production. Despite bringing 18 new fields online during 1996, national crude oil output was estimated to have increased only slightly to about 25 million barrels. At the beginning of the year, Perenco Plc. of the United Kingdom acquired N.V. Turkse Shell's operations in the southeast. Civil unrest adversely affected petroleum exploration activity in the southeastern producing region (U.S. Department of State, 1997).

In December, crude oil began to flow through the Iraqi-Turkish pipeline for the first time since United Nations' sanctions were imposed in 1990. Under U.N. Resolution 986, Iraq was allowed to sell crude oil to fund food and drug purchases. Turkey contracted to buy about 75,000 barrels per day of the Iraqi crude oil. In addition to normal imports, an estimated 11 million barrels per year of diesel fuel was reportedly brought across the border from Iraq (Washington Times, 1995; Reuters, 1997).

## Reserves

Turkey's mineral inventory is diverse and large, but many of the deposits, especially for metallic minerals, are small by world standards. Resources of metallic commodities minable by large-scale methods are known for bauxite, chromite, copper and copper-zinc, gold, iron, and silver. Turkey is better known for its deposits of industrial minerals, most significant of which are barite, boron, clays, limestone and marble, magnesite, perlite, pumice, strontium, and trona. The country has large lignite reserves. The crude oil reserves are cumulatively significant but hosted in a large number of small fields. Natural gas reserves are small.

Many of Turkey's mineral deposits remain unevaluated in terms of current economic criteria, including the use of mechanized mining. The most complete official inventory of Turkish mineral resources is a 1989 MTA report (Erseçen, 1989).

## Infrastructure

Turkey's extensive road and railroad infrastructure was heavily used for the transport of mineral commodities. Turkey had 2,092 km of crude petroleum and 2,321 km of refined petroleum products pipelines. The longest stretch of pipeline was the 641-km twin line connecting Iraq with the Ceyhan oil-loading facility at Yumurtalık. Ceyhan was also the terminus for a 447-km pipeline to the refinery in Kırıkkale. The oil port at Dörtyol, 28 km north of İskenderun, was the terminus of a 494-km pipeline from the oil refinery at Batman, with shorter spurs from this line to the oilfields near Batman (Şelmo) and around Adıyaman. Turkey had about 900 km of natural gas pipeline, which was used to import natural gas from Russia.

Turkey had many ports capable of handling mineral-commodity shipments. Major coal-importing ports included İskenderun and Ereğli. Chromite was shipped from various Anatolian ports on the Marmara coast, as well as from Antalya and İskenderun, which handled all Turkey's ferrochrome exports. Steel, steel scrap, and iron ore imports also were handled at many ports, particularly Aliağa, Ereğli, İskenderun, and Mersin and at various sites in the İstanbul-İzmit area. Turkey's boron minerals and chemicals were exported from Bandırma. Copper concentrates, ore, and blister were shipped from Samsun, and copper concentrates, from Hopa near Artvin, facilities at Rize, and İskenderun. Marine terminals at Ambarlı were used to ship cement.

Total electrical generating capacity in 1996 was 21,217 megawatts (MW), up from 20,951 MW capacity in 1995. (Barham, 1997a). Because of electrical power demand growing at an estimated 8% to 10% per year, Turkey was in the process of greatly expanding its electrical generating capacity.

### Outlook

The health of Turkey's mineral economy is likely to hinge significantly on the success of the ongoing privatization program. The economy appears unable to support continued high levels of public spending. Turkey's value-added secondary, mineral sector would appear to be more resilient to future world market fluctuations than is the primary mineral sector. Environmental issues are likely to assume an increasing role in Turkey's economic affairs. Lengthy mine-permitting procedures could lessen exploration interest in the country.

### References Cited

Barham, John, 1997a, Ankara hopes to muddle through: Financial Times [London], April 2, p. 11.

———1997b, Living in the long shadow of Atatürk: Financial Times [London], May 26, p. 23.

Bodgener, Jim, 1997, Turkey knuckles down to fight inflation battle: Middle East Economic Digest, v. 41, no. 46, November 14, p. 2-3.

Butter, David, Ash, Toby, and Bodgener, Jim, 1997, A country pulled in two directions: Middle East Economic Digest, v. 41, no. 22, May 30, p. 2-3.

Erseçen, Necdet, 1989, Known ore and mineral resources of Turkey: Maden Tetkik ve Arama Genel Müdürlüğü Bulletin, no. 185, 108 p.

Metal Bulletin, 1996, Turkish smelter plans expansion to 6,000 tpy: Metal Bulletin, no. 8068, April 4, p. 9.

———1997, Insufficient exploration hits Turkish copper: Metal Bulletin, no. 8193, July 7, p. 7.

Middle East Economic Digest, 1995, Turkey—In brief: Middle East Economic Digest, v. 39, no. 39, September 29, p. 27.

Mining Journal, 1996, Inmet breach: Mining Journal, v. 327, no. 8403, November 8, p. 382

Öktem, M.M., 1997, Endüstriyel hammaddeler ihracatimiz ve ihracatta karşilaşilan sorunlar: Metal Maden, v. 7, no. 41, p. 58-59.

Our Turkish Correspondent, 1996, Iranian group buys Cinkur zinc refinery: Metal Bulletin, no. 8094, July 8, p. 5.

Reuters, 1997, Iraqi diesel trade with Turkey cut sharply—Kurds: Yahoo Finance, November 12. (Accessed November 17, 1997, on the World Wide Web at URLhttp:\\biz.yahoo.com/finance/971112/iraqi_diesel_trade_w_1.html)

U.S. Department of State, 1997, Turkey—Consular information sheet: U.S. Department of State, July, 1997, 8 p.

Washington Times, 1995, Truckers in Turkey violate U.N. sanctions against Baghdad: Washington Times, March 6, p. 11.

### Other Sources of Information

General Directorate of Mines
(Maden Genel Müdürlüğü)
Ihlamur Sokak No. 2, Maro Han
Sihhiye, Ankara
Turkey
General Directorate of Petroleum Works
(Petrol İşleri Genel Müdürlüğü)
Ziya Gölkalp Cad. No. 41 Yenişehir
Ankara, Turkey
Telephone: (90) 312-435-4578
İstanbul Mineral and Metal Exporters' Association
(İstanbul Maden ve Metaller İhracatçıları Birliği)
İnönü Cad. Devres Han No. 96
Kat. 5, 80090 Gümüşsuyu—Taksim
İstanbul, Turkey
Telephone: (90) 212-293-4010
Fax: (90) 212-293-3329 and 293-8607
Mineral Research and Exploration General Directorate
(Maden Tetkik ve Arama Genel Müdürlüğü) (MTA)
Eskişehir Yolu Üzeri Balgat,
06520 Ankara, Turkey
Telephone: (90) 4-287-9159
Fax: (90) 4-287-9151
State Institute of Statistics
(T.C. Başbakanlık Devlet İstatistik Enstitüsü)
06100 Necatibey Cad. 114
Ankara, Turkey
Telephone: (90) 312-425-8442
Fax: (90) 312-417-0432

## TABLE 1
## TURKEY: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

| Commodity | 1992 | 1993 | 1994 | 1995 | 1996 e/ |
|---|---|---|---|---|---|
| METALS | | | | | |
| Aluminum: | | | | | |
| Bauxite 2/ | 419,872 | 538,439 | 445,020 | 232,278 | 544,513 3/ |
| Alumina: | | | | | |
| Gross weight | 156,474 | 169,195 | 155,299 | 171,978 | 159,298 3/ |
| Al content | 81,570 | 88,195 | 80,952 | 91,000 e/ | 83,000 |
| Metal, smelter | 58,550 | 58,503 | 59,750 | 61,514 r/ | 60,000 |
| Antimony: | | | | | |
| Ore, mine output: | | | | | |
| Gross weight | 5,065 | 2,100 | 1,415 | 7,856 r/ | 8,000 |
| Sb content | 309 | 111 | 75 | 416 r/ | 450 |
| Concentrates: | | | | | |
| Gross weight | 218 | 93 | 90 e/ | 1,163 r/ | 1,200 |
| Sb content | 131 e/ | 59 | 55 e/ | 291 r/ | 300 |
| Cadmium | 23 | 31 | 22 | 23 e/ | 33 |
| Chromite: | | | | | |
| Gross weight (34% to 43% chromic oxide) | 758,732 | 767,313 | 1,270,431 | 2,080,043 r/ | 1,668,285 3/ |
| Salable product | 531,112 | 642,376 | 501,851 | 1,460,000 r/ e/ | 1,171,000 |
| Copper: | | | | | |
| Mine output (exclusive of pyrite): | | | | | |
| Gross weight | 3,158,674 | 3,343,532 | 3,346,490 | 3,185,628 | 4,800,000 |
| Cu content of ore | 38,554 | 39,163 | 34,902 | 40,085 r/ | 58,000 |
| Cu content of pyrite e/ | 620 | 350 r/ | 350 r/ | 2,100 r/ | 2,100 |
| Concentrates (exclusive of pyrite): | | | | | |
| Gross weight | 143,196 | 140,165 | 139,919 | 141,000 e/ | 240,000 |
| Cu content | 26,500 e/ | 23,879 | 28,891 | 24,000 e/ | 48,000 |
| Metal: | | | | | |
| Smelter output (primary + secondary) | 31,568 | 39,638 | 30,400 | 33,700 e/ | 38,600 |
| Refined e/ | 104,000 | 92,400 | 82,700 | 98,500 e/ | 120,000 |
| Gold, byproduct of base metals refining e/ kilograms | 1,250 | 1,110 | 996 | 1,200 | 1,200 |
| Iron and steel: | | | | | |
| Iron ore: | | | | | |
| Gross weight thousand metric tons | 5,917 | 6,480 | 5,755 | 4,931 r/ | 6,404 3/ |
| Fe content e/ do. | 3,200 | 3,324 | 3,148 | 2,750 r/ | 3,500 |
| Metal: | | | | | |
| Pig iron and ferroalloys: | | | | | |
| Ferrochromium | 85,755 | 90,030 | 97,585 | 94,251 r/ | 101,450 3/ |
| Ferrosilicon | 1,250 | 4,680 | 4,930 | 4,900 | 5,000 |
| Pig iron and other ferroalloys thousand metric tons | 4,508 | 4,353 | 4,604 | 4,363 r/ | 5,263 3/ |
| Steel, crude including castings do. | 10,343 | 11,838 | 12,074 | 12,744 | 13,382 3/ |
| Lead: | | | | | |
| Mine output, Pb and Pb-Zn ores: | | | | | |
| Gross weight | 233,944 | 179,731 | 232,140 | 253,100 | 289,072 3/ |
| Pb content | 10,800 e/ | 11,448 | 11,158 | 10,376 r/ | 10,000 |
| Concentrates: | | | | | |
| Gross weight | 28,000 e/ | 8,021 | 5,683 | 5,318 r/ | 5,300 |
| Pb content | 7,000 e/ | 2,571 | 1,279 | 1,196 r/ | 1,200 |
| Metal, refined e/ | 9,000 | 5,000 | 5,100 | 4,000 | 4,000 |
| Manganese ore, gross weight 5/ | 10,000 e/ | 37,491 | 34,500 | 49,700 r/ | 37,000 |
| Mercury kilograms | 5,000 | -- | -- | -- | -- |
| Silver, mine output, Ag content e/ 6/ do. | 103,000 | 103,000 | 65,000 | 70,000 r/ | 70,000 |
| Zinc: | | | | | |
| Mine output, Zn and Pb-Zn ore: | | | | | |
| Gross weight | 306,960 | 231,756 | 297,252 | 73,110 r/ | 90,000 |
| Zn content | 32,514 | 20,500 e/ | 26,300 e/ | 9,118 r/ | 12,000 |
| Concentrates: e/ | | | | | |
| Gross weight | 37,000 | 23,000 | 30,000 | 9,760 r/ | 12,000 |
| Zn content | 13,000 | 8,000 | 10,000 | 5,774 r/ | 6,600 |
| Metal, smelter, primary | 18,770 | 18,500 | 18,567 | 17,050 r/ | 24,000 |

See footnotes at end of table.

### TABLE 1--Continued
### TURKEY: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

| Commodity | | 1992 | 1993 | 1994 | 1995 | 1996 e/ |
|---|---|---|---|---|---|---|
| INDUSTRIAL MINERALS | | | | | | |
| Abrasives, natural, emery | | 41,474 | 10,988 | 12,000 | 14,149 r/ | 14,000 |
| Barite, run of mine | | 311,335 | 118,367 | 116,220 | 153,719 | 160,000 |
| Boron minerals: | | | | | | |
| Run of mine | | 1,796,100 | 1,892,356 | 2,092,032 | 1,768,919 | 2,379,160 3/ |
| Concentrates | | 1,058,885 | 1,079,135 | 1,139,980 | 1,143,994 r/ | 1,200,000 |
| Cement, hydraulic | thousand metric tons | 28,607 | 31,241 | 29,493 | 33,153 | 35,214 3/ |
| Clays: | | | | | | |
| Bentonite | | 123,516 | 456,597 | 516,187 | 602,499 r/ | 600,000 |
| Kaolin | | 134,416 | 210,356 | 179,775 | 489,635 r/ | 490,000 |
| Other | | 500,000 e/ | 665,351 | 956,012 | 1,649,192 r/ | 1,600,000 |
| Feldspar, run of mine | | 464,736 | 366,166 | 502,608 | 760,250 r/ | 1,040,000 |
| Fluorspar | | 3,074 | 4,000 e/ | 6,671 | 8,873 r/ | 8,900 |
| Glass, crude e/ | thousand metric tons | 1,171 3/ | 1,300 | 1,400 | 1,400 | 1,500 |
| Graphite, run of mine e/ | | 20,978 3/ | 20,000 | 20,000 | 20,000 | 20,000 |
| Gypsum, other than that for cement | | 278,402 | 492,705 | 596,962 r/ | 596,967 r/ | 600,000 |
| Lime 7/ | thousand metric tons | 1,582 | 1,767 | 1,800 e/ | 897 r/ | 900 |
| Magnesite, run of mine | | 1,224,900 | 525,640 | 1,279,614 | 1,928,064 r/ | 2,273,418 3/ |
| Meerschaum | kilograms | 3,000 | 3,050 | 2,350 | 1,000 r/ | 500 3/ |
| Nitrogen, N content of ammonia | | 344,275 | 325,800 | 350,000 e/ | 366,000 r/ | 518,800 |
| Perlite, run of mine | | 280,883 | 147,864 | 164,582 | 171,058 r/ | 175,000 |
| Phosphate rock (salable product) | | 64,803 | 77,671 | -- | -- | -- |
| Pumice 8/ | | 736,316 | 1,224,114 | 947,174 | 1,125,820 r/ | 1,125,000 |
| Pyrites, cupreous, gross weight | | 89,000 | 50,000 e/ | 50,000 e/ | 307,992 r/ | 300,000 |
| Salt, NaCl, all types | thousand metric tons | 1,418 | 1,526 | 1,353 | 1,444 r/ | 1,400 |
| Silica sand, washed product e/ | do. | 510 | 350 | 415 | 310 | 385 |
| Sodium compounds, n.e.s.: | | | | | | |
| Soda ash (trona) e/ | do. | 385 | 385 | 385 | 385 | 400 |
| Sulfate, concentrates | | 75,058 | 170,680 | 307,049 | 314,192 r/ | 300,000 |
| Stone: | | | | | | |
| Dolomite | | 255,310 | 376,518 | 378,004 | 425,877 r/ | 425,000 |
| Limestone, other than for cement | thousand metric tons | 6,937 | 10,852 | 11,000 e/ | 20,496 r/ | 20,500 |
| Marble e/ | do. | 550 | 730 | 750 | 272 r/ | 270 |
| Quartzite | | 1,310,259 | 1,205,694 | 1,350,299 | 1,364,558 r/ | 1,350,000 |
| Strontium minerals, celestite: e/ | | | | | | |
| Run of mine | | 59,000 | 68,000 | 45,000 | 50,000 | 50,000 |
| Concentrates | | 37,940 3/ | 43,700 | 25,000 | 30,000 | 30,000 |
| Sulfates, n.e.s., aluminum sulfate (alunite) | | 9,278 | 13,500 | 12,165 | 9,763 r/ | 10,000 |
| Sulfur: | | | | | | |
| Native, other than Frasch | | 22,700 | 17,400 e/ | 16,673 | 17,000 e/ | -- |
| S content of pyrites e/ | | 40,000 | 26,758 3/ | 27,000 | 130,000 r/ | 130,000 |
| Byproduct: | | | | | | |
| Petroleum | | 16,861 | 21,000 | 25,000 e/ | 26,000 e/ | 25,000 |
| Other e/ | | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 |
| Total e/ | | 84,561 | 70,158 | 73,673 | 178,000 r/ | 160,000 |
| Talc e/ | | 3,918 | 4,000 | 4,000 | 4,000 | 4,000 |
| MINERAL FUELS AND RELATED MATERIALS | | | | | | |
| Asphalt, natural | | 249,535 | 309,348 | 108,364 | 219,848 | 126,751 3/ |
| Carbon black e/ | | 35,000 | 34,878 3/ | 35,000 | 39,975 r/ | 35,000 |
| Coal: | | | | | | |
| Hard coal, run of mine | thousand metric tons | 5,225 | 4,609 | 4,211 | 3,377 r/ | 3,606 3/ |
| Lignite, run of mine | do. | 50,439 | 51,359 | 55,038 | 56,031 r/ | 58,298 3/ |
| Coke and semicoke | do. | 3,257 | 2,899 | 2,799 | 3,021 | 3,217 3/ |
| Gas: | | | | | | |
| Natural, marketed | thousand cubic meters | 197,796 | 199,739 | 198,630 | 181,515 r/ | 203,967 3/ |
| Coal, manufactured e/ | do. | 38,789 3/ | 35,000 | 35,000 | 35,000 | 37,000 |

See footnotes at end of table.

TABLE 1--Continued
TURKEY: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

| Commodity | | 1992 | 1993 | 1994 | 1995 | 1996 e/ |
|---|---|---|---|---|---|---|
| MINERAL FUELS AND RELATED MATERIALS--Continued | | | | | | |
| Petroleum: | | | | | | |
| Crude | thousand 42-gallon barrels | 30,656 | 27,871 | 26,399 | 24,124 | 25,000 |
| Refinery products: | | | | | | |
| Liquefied petroleum gas | do. | 7,755 | 8,197 | 8,503 | 9,185 | 9,580 3/ |
| Gasoline | do. | 23,846 | 27,808 | 29,521 | 31,746 | 30,950 3/ |
| Naphtha | do. | 10,588 | 10,617 | 10,761 | 12,110 | 13,308 3/ |
| Jet fuel | do. | 5,495 | 9,015 | 10,380 | 12,119 | 11,324 3/ |
| Kerosene | do. | 1,125 | 1,282 | 819 | 605 | 726 3/ |
| Distillate fuel oil 9/ | do. | 49,570 | 54,103 | 55,197 | 59,556 | 55,838 3/ |
| Lubricants e/ | do. | 1,985 3/ | 2,000 | 2,000 | 2,000 | 2,000 |
| Residual fuel oil | do. | 57,705 | 57,981 | 50,640 | 52,043 | 49,459 3/ |
| Asphalt | do. | 5,657 | 7,812 | 5,389 | 5,940 | 7,233 3/ |
| Unspecified 10/ e/ | do. | 7,007 3/ | 6,700 | 6,700 | 6,700 | 4,000 |
| Total | do. | 170,733 | 185,515 e/ | 179,910 e/ | 192,004 | 184,418 |

e/ Estimated. r/ Revised.

1/ Table includes data available through Jan. 7, 1998. Large quantities of construction materials (clay, sand and gravel) are quarried. Also quarried are basalt, diabase, granite, onyx, sandstone, serpentine, slate, and travertine for building stone and limestone and gypsum for cement manufacture; however, information is inadequate to make estimates of output levels.

2/ Data are for public sector only. Data for private-sector production are not available, but production is believed to be about 30,000 metric tons per year.

3/ Reported figure.

4/ Data are estimated content of Turkish copper refinery tankhouse slimes.

5/ Does not include manganiferous iron ore from the Deveci Mine, production of which amounts to several hundred thousand tons per year and has a manganese content from 3% to 5%.

6/ Includes estimated content of base metals refinery tankhouse slimes.

7/ Data are lime produced for steel production and do not include the widespread artisanal production of lime for whitewash and sanitation purposes.

8/ Turkish pumice production is officially reported in cubic meters and has a density reported to range from 0.5 to 1.0 ton per cubic meter. Values in this table have been converted by using 1 cubic meter = 0.75 ton.

9/ Diesel fuel and special heating oil.

10/ Includes refinery fuel and losses.

## TABLE 2
## TURKEY: STRUCTURE OF THE MINERAL INDUSTRY FOR 1996

(Thousand metric tons unless otherwise specified)

| Major commodities | Major operating companies and major equity owners[1] [2] | Location of main facilities | Annual capacity |
|---|---|---|---|
| Aluminum and bauxite | Etibank Milas Boksit İşletmeleri Müdürlüğü (Etibank, 100%) | Open-pit mine at Milas, 127 kilometers southwest of Denizli | 150 diaspore. |
| Do. | Etibank Seydişehir Alüminyum Tesisleri Müessesesi Müdürlüğü (Etibank, 100%) | Doğankuzu and Mortaş bauxite mines at Madenli, 25 kilometers south of Seydişehir | 450 bauxite. |
| Do. | do. | Alumina refinery and aluminum smelter at Seydişehir | 200 alumina,<br>60 aluminum. |
| Barite | Barit Maden Türk A.Ş. | Mines near Sivas and Adana | 220 ground barite.[3] |
| Do. | Baser Maden Sanayi ve Ticaret A.Ş. | Mines at Isparta and Konya | 90 ground barite. |
| Do. | Emas Endüstri Mineralleri A.Ş. | Mine at Muş | 100 ground barite. |
| Do. | Etibank Beyşehir Barit İşletmesi (Etibank, 100%) | Mine at Beyşehir, 72 kilometers southwest of Konya | 70 barite ore. |
| Do. | Antalya Elektrometalurji Sanayi İşletmesi Müessesesi Müdürlüğü (Ado Mining, 100%) | Grinding plant at Antalya | 100 ground barite. |
| Do. | Polbar Barit Endüstrisi A.Ş. | Mine near Antalya | 120 ground barite. |
| Boron minerals | Etibank Bigadiç Madencilic İşletmeleri (Etibank, 100%) | Bigadiç, 38 kilometers southeast of Balıkesir | 200 colemanite concentrate, 128 ulexite concentrate. |
| Do. | Etibank Emet Kolemanit İşletmeleri (Etibank, 100%) | Espey and Hisarcık Mines near Emet, 62 kilometers west-southwest of Kütahya | 510 colemanite concentrate. |
| Do. | Etibank Kestelek Kolemanit İşletmeleri (Etibank, 100%) | Kestelek, 80 kilometers west-southwest of Bursa | 100 colemanite concentrate. |
| Do. | Etibank Kırka Boraks İşletmeleri Müessesesi Müdürlüğü (Etibank, 100%) | Kırka, 61 kilometers north of Afyon | 800 tincal concentrate. |
| Cement | Adana Çimento Sanayii T.A.Ş. (OYAK—Armed Forces Mutual Assistance Fund), 48.74%, other Government,[4] 47.28%) | 12 kilometers east of Adana | 2,185. |
| Do. | Akçansa. (Sabanci Group, 50%; S.A. Cimenteries CBR, 50%) | Büyükçekmece, 30 kilometers west of İstanbul and Mahmudiye, 40 kilometers south of Çanakkale | 6,000. |
| Do. | Aslan Çimento A.Ş. (Lafarge Coppée, 86%) | Darıca, 40 kilometers southeast of İstanbul | 1,600. |
| Do. | Baştaş Başkent Çimento Sanayii ve Tic. A.Ş. | Elmadağ, 35 kilometers east of Ankara | 1,320. |
| Do. | Batı Anadolu Çimento Sanayii A. . Ş | Bornova, 10 kilometers northeast of İzmir | 2,550. |
| Do. | Çimento Sanayi ve Ticaret A.Ş. Sabanci Holdin s A.S.) | Mersin | 1,900. |

See footnotes at end of table.

## TABLE 2—Continued
## TURKEY: STRUCTURE OF THE MINERAL INDUSTRY FOR 1996

(Thousand metric tons unless otherwise specified)

| Major commodities | Major operating companies and major equity owners[1] [2] | Location of main facilities | Annual capacity |
|---|---|---|---|
| Cement—Continued: | Yibitaş Lafarge Group (Yibitaş Holdings A.S., 50%; Lafarge Coppée, 50%) | Çorum, Sivas and Yozgat plants | 2,000. |
| Do. | Nuh Çimento Sanayi A.Ş. | Near Hereke 30 kilometers west of İzmit | 2,000. |
| Do. | Rumeli Çimento Sanayi ve Tic. A.Ş. | Bartın, Gaziantep, Ladik, Trabzon, and Şanlıurfa plants | 4,000. |
| Do. | OYAK Group | 4 plants | 2,280. |
| Do. | Set Group Holding (Soc. des Ciments Français, France, 100%) | 5 plants in Marmara and Aegean coast regions | 3,300. |
| Do. | Türkiye Çimento ve Toprak Sanayii T.A.Ş. (ÇİTOSAN) (Government, 100%) | 7 plants | 4,000.[e] |
| Chromium: | | | |
| Chromite ores and concentrates | Etibank Şark Kromları İşletmesi Müessesesi Müdürlüğü (Etibank, 100%) | Mines at Güleman, 40 kilometers southeast of Elazığ | 150 lump ore,<br>70 concentrate. |
| Do. | Etibank Üçköprü Maden İşletmesi Müessesesi Müdürlüğü (Etibank, 100%) | 8 mines in Göcek District, west of Fethiye | 15 lump ore,<br>30 concentrate. |
| Do. | Birlik Madencilik Ticaret ve Sanayi A.Ş. | Mines in Kayseri, Erzurum, and Erzincan Provinces | 240 lump ore. |
| Do. | Akpaş Madencilik ve Paz. ve Ticaret A.Ş. | Mines in Erzurum, Erzincan, and Kayseri Provinces | 200 lump ore,<br>70 concentrate. |
| Do. | Bilfer Madencilik A.Ş. | Mines in Kayseri and Sivas Provinces | 350 lump ore, |
| Do. | Türk Maadin Şirketi (AŞ) | Mines at Köyceğiz, 56 kilometers northwest of Fethiye, and at Eskişehir | 24 lump ore,<br>88 concentrate. |
| Do. | Dedeman Madencilik Turizm Sanayi ve Ticaret A.Ş. | Kayseri Province | 56 lump ore. |
| Do. | Egemetal Madencilik A.Ş. | Mines in Bursa, Mersin, Eskişehir, and Erzurum Provinces | 250 lump ore,<br>40 concentrate. |
| Do. | Pinar Madencilik ve Turizm A.Ş. | Mines in Kayseri and Adana Provinces | 25 lump ore,<br>14 concentrate. |
| Do. | Akdeniz Madencilik Ticaret ve Sanayi A.Ş. | Adana | 25 lump ore.[e] |
| Do. | Other (9) private producers | Mines in Köyceğiz, Bursa, Adana, İskenderun, and Eskişehir Provinces | 114 lump ore,<br>12 concentrate. |
| Ferrochrome | Etibank Elazığ Ferrokrom İşletmesi (Etibank, 100%) | Ferrochrome plant, 50 kilometers east of Elazığ | 150 high-carbon ferrochrome. |
| Do. | Etibank Antalya Elektrometalurji Sanayi İşletmesi Müessesesi Müdürlüğü (Etibank, 100%) | Ferrochrome plant at Antalya | 11 low-carbon ferrochrome. |

See footnotes at end of table.

## TABLE 2—Continued
## TURKEY: STRUCTURE OF THE MINERAL INDUSTRY FOR 1996

(Thousand metric tons unless otherwise specified)

| Major commodities | Major operating companies and major equity owners[1] [2] | Location of main facilities | Annual capacity |
|---|---|---|---|
| Coal: | | | |
| Hard coal | Türkiye Taşkömürü Kurumu Genel Müdürlüğü (TTK) (Government, 100%) | Mines in 5 coalfields near Zonguldak | 7,000.[e] |
| Lignite | Türkiye Kömür İşletmeleri Kurumu (TKİ) (Government, 100%) | 38 mines throughout Turkey | 49,000.[e] |
| Do. | Private-sector producers | About 200 small mines throughout Turkey | 8,000.[e] |
| Copper | Etibank Küre Bakırlı Pirit İşletmesi Müessesesi Müdürlüğü (Etibank, 100%) | Open-pit copper and pyrite mine at Küre, 14 kilometers south of İnebolu | 90 copper concentrate,<br>460 pyrite concentrate. |
| Do. | Çayeli Bakır İşletmeleri A.Ş. (Inmet Mining Corp., 49%, Etibank, 45%, Gama Endustri, 5%, and Gama Holdin , 1% | Çayeli Mine, 85 kilometers east of Trabzon y | 24 copper concentrate. |
| Do. | Etibank Ergani Bakır İşletmesi Müessesesi Müdürlüğü (Etibank, 100%) | Open-pit mine and smelter at Ergani, 59 kilometers southeast of Elazığ | 16 blister copper.[3] |
| Do. | Karadeniz Bakır İşletmeleri A.Ş. (Etibank, 99.91%) | Mine and concentrator at Murgul near Artvin; mines at Sürmene and Espiye near Trabzon | 175 copper concentrate,[e]<br>20 blister copper.[e] [3] |
| Do. | do. | Open-pit Kutlular Mine near Trabzon | 15 copper concentrate.[e] |
| Do. | do. | Underground mine near Küre | 95 ore.[e] |
| Do. | Karadeniz Bakır İşletmeleri A.Ş. (Etibank, 99.91%) | Smelter and acid plant at Samsun | 38 blister copper. |
| Do. | Rabak Elektrolitik Bakır ve Mam. A. . ) | İstanbul | 35 refined copper. |
| Do. | Sarkuysan Elektrolitik Bakır Sanayii ve Ticaret A.Ş. | Gebze, 40 kilometers west of Izmit | 70 refined copper. |
| Do. | Er-Bakır Elektrolitik Bakır Mam. A.Ş. | Denizli | 18 refined copper. |
| Iron and steel: | | | |
| Iron ore | Türkiye Demir ve Çelik İşletmeleri Genel Müdürlüğü (TDÇI) (Government, 100%) | Divriği Mine, 115 kilometers northwest of Elazığ | 3,000 ore;[e]<br>1,100 pellets;<br>600 concentrate;<br>500 lump ore. |
| Do. | do. | Deveci Mine at Hekimhan, 112 kilometers west of Elazığ | 750 ore.[e] |
| Do. | Bilfer Madencilik A.Ş. | Mines near Divriği | 1,500 ore. |
| Steel | Türkiye Demir ve Çelik İşletmeleri Genel Müdürlüğü (TDÇI) (Government, 100%) | İskenderun | 2,200 crude steel. |
| Do. | Ereğli Demir ve Çelik Fabrikaları T.A.Ş. (Erdemir) (Government,[4] 51.66%, others, 48.34%) | Ereğli | 3,000 crude steel. |

See footnotes at end of table.

TABLE 2—Continued
TURKEY: STRUCTURE OF THE MINERAL INDUSTRY FOR 1996

(Thousand metric tons unless otherwise specified)

| Major commodities | Major operating companies and major equity owners[1] [2] | Location of main facilities | Annual capacity |
|---|---|---|---|
| Iron and steel—Continued: | | | |
| Steel—Continued: | Karabük Demir ve Çelik A.S. | Karabük | 680 crude steel. |
| Do. | Makina ve Kimya Endüstrisi Kurumu (MKEK) (Government, 100%) | Kırıkkale, 62 kilometers east of Ankara | 60 crude steel. |
| Do. | Çolakoğlu Metalurji A.Ş. | Gebze, 40 kilometers west of İzmit | 650 crude steel, 1,050 semifinished steel. |
| Do. | Çukurova Çelik Endüstrisi A.Ş. | Aliağa, 40 kilometers north-northeast of İzmir | 2,000 semifinished steel. |
| Do. | Diler Demir Çelik Endüstri ve Ticaret A.Ş. | İzmit | 310 semifinished steel. |
| Do. | Ekinciler Demir ve Çelik Sanayi A.Ş. | Arc furnace and 1 rolling mill at İskenderun. Rolling mills at Adana, Karabük, and near İskenderun (Payas) | 600 semifinished steel. |
| Do. | Habaş Sinai ve Tibbi Gazlar İstihsal Endüstrisi A.Ş. | Aliağa | 600 semifinished steel. |
| Do. | İzmir Demir Çelik Sanayi A.Ş. (İDÇ) (İş-Bakansi, 60%, others, 30%) | do. | 550 semifinished steel. |
| Do. | Kroman Çelik Sanayii A.Ş. | Gebze, 40 kilometers west of İzmit | 420 semifinished steel. |
| Do. | Metaş İzmir Metalurji Fabrikası T.A.Ş. | İzmir | 450 special and semifinished steel. |
| Do. | Sivas Demir-Çelik İşletmeleri A.Ş. | Sivas | 450 semifinished steel. |
| Do. | Other private-sector companies. | Plants near Bursa, İzmir, and İstanbul | 1,448 semifinished steel. |
| Magnesite | ÇİTOSAN Konya Krom Magnezit Tuğla Sanayii A.Ş. (Government, 100%) | Konya | 40 dead-burned magnesite, 38 bricks, 12 mortar. |
| Do. | Kümaş Kütahya Manyezit İşletmeleri A.Ş. (Zeytınoğlu Holding A.S., 97.44%) | Kütahya | 144 dead-burned magnesite, 46 bricks. |
| Do. | Comag Continental Madencilik Sanayii Tic. A.Ş. | Mines at Tavşanlı, 40 kilometers northwest of Kütahya, and near Bursa | 40 dead-burned magnesite. |
| Do. | Magnesit A.Ş. (Veitscher Magnesitwerke AG, Austria) | Mine at Margı, 50 kilometers northeast of Eskişehir | 80 dead-burned magnesite. |
| Mercury metric tons | Etibank Haliköy Maden İşletmesi (Etibank, 100%) | Mine near Ödemiş, about 70 kilometers southeast of İzmir | 190 mercury.[3] |
| Do. | Etibank Konya Çiva İsletmesi (Etibank, 100%) | Mine at Sarayönü, 47 kilometers north of Konya | 100 mercury.[3] |

See footnotes at end of table.

### TABLE 2—Continued
### TURKEY: STRUCTURE OF THE MINERAL INDUSTRY FOR 1996

(Thousand metric tons unless otherwise specified)

| Major commodities | Major operating companies and major equity owners[1] [2] | Location of main facilities | Annual capacity |
|---|---|---|---|
| Petroleum and natural gas: | | | |
| Crude petroleum thousand 42-gallon barrels | Türkiye Petrolleri Anonim Ortaklığı (TPAO) (Government, 100%) | Production from 34 fields, mostly in Diyarbakır, Gaziantep, and Siirt Provinces | 19,500.[e] |
| Do. do. | Perenco Plc. | Production from 27 fields in Diyarbakır and Siirt Provinces | 5,000.[e] |
| Do. do. | Other producers (private sector and in joint venture with TPAO) | Production from 27 fields, mostly in Diyarbakır, Gaziantep and Siirt Provinces | 9,000.[e] |
| Refined petroleum do. | Türkiye Petrol Rafinerileri A.Ş. (TÜPRAŞ) (Government,[4] 100%) | Refinery at Batman | 7,700 crude input. |
| Do. do. | do. | Refinery at Aliağa | 70,000 crude input. |
| Do. do. | do. | Refinery at İzmit | 91,000 crude input. |
| Do. do. | do. | OAR refinery at Kırıkkale | 35,000 crude input. |
| Do. do. | Anadolu Tasfiyehanesi A.Ş. (ATAŞ) | Refinery at Mersin | 30,800 crude input. |
| Natural gas thousand cubic meters | Türkiye Petrolleri Anonim Orktaklığı (TPAO) (Government, 100%) | Çamurlu Field, Siirt Province | 800.[e] |
| Do. do. | do. | Hamitabat Field, in Thrace | 205,000.[e] |
| Do. do. | do. | Umurca Field, in Thrace | 10.[e] |
| Silver kilograms | Etibank 100. Yil Gümüş Madeni İşletmeleri Müessesesi Müdürlüğü (Etibank, 100%) | Aktepe Mine near Gümüşköy, 20 kilometers west-northwest of Kütahya | 75,000.[e] |
| Strontium | Barit Maden Türk A.Ş. | Mine at Akkaya, 25 kilometers south of Sivas | 100 celestite concentrate.[e] |
| Sulfur | Keçiborlu Kükürt İşletmesi Müessesesi Müdürlüğü (Etibank, 100%) | Mine at Keçiborlu, 30 kilometers northwest of Isparta | 55. |
| Do. | Türkiye Petrol Rafinerileri A.Ş. (TÜPRAŞ) (Government,[4] 100%) | Recovery plants at company oil refineries | 23. |
| Zinc | Çayeli Bakır İşletmeleri A.Ş. (Inmet Mining Corp., 49%, Etibank, 45%, Gama Endustri, 5%, and Gama Holding, 1% | Çayeli Mine, 85 kilometers east of Trabzon | 36 zinc concentrate. |
| Do. | Çinko Kurşun Metal Sanayii A.Ş. (ÇİNKUR) (Kayseri Maden Metal ve Ticaret A.Ş., 85%) | Zinc-lead smelter at Kayseri | 34 zinc, 125 tons cadmium. |

[e] Estimated.
[1] Turkish private-sector ownership unless otherwise noted.
[2] Etibank refers to the 100% Government-owned group administered by Etibank Genel Müdürlüğü.
[3] Facility was idle in 1996.
[4] Shares are held by the Public Participation Fund Administration (PPFA) for eventual privatization.

## THE MINERAL INDUSTRY OF

# UNITED ARAB EMIRATES

### By Bernadette Michalski

The production of crude petroleum and natural gas was the most important facet of the United Arab Emirates'[1] (UAE) mineral industry and the economy. Crude petroleum and natural gas, chiefly from Abu Dhabi, accounted for about 80% of Government revenues and 34% of the country's gross domestic product, which was $42.7[2] billion in 1996.

Aluminum metal from Dubai, ammonia from Abu Dhabi, cement manufactured in six of the seven emirates, and chromite from Fujairah were significant in terms of production volume and export earnings. Dubai also was one of the world's leading gold bullion importers and value-added jewelry exporting centers.

All mineral resources were owned and controlled by the individual emirates and only loosely administered by the Federal Government. The Ministry of Petroleum and Mineral Resources coordinated Federal UAE activities with the international community. The Government continued to encourage the expansion of the country's mineral production capacity.

The Federal Environment Authority (FEA), organized under Federal Law No. 7 of 1993, was responsible for pollution control in the Emirates. The FEA drafted new environmental legislation to combat pollution from oceangoing tankers.

Crude oil production averaged 2.16 million barrels per day (Mbbl/d) and was primarily from Abu Dhabi, which produced 1.95 Mbbl/d. Additional petroleum and natural gas production was from Dubai and Sharjah. Ras al-Khaimah realized a portion of the production from the offshore Bukha Field shared with Oman. Umm al-Qaiwain held a 20% share in production from the Mubarak Field in Sharjah. Production was restrained by the Organization of Petroleum Exporting Countries (OPEC) quota limiting production from the UAE to 2.16 Mbbl/d, leaving Abu Dhabi with about 500,000 barrels per day (bbl/d) of unused production capacity.

Although the variety and output of minerals produced was small, demand for domestic industrial minerals continued to stimulate domestic production. *(See table 1.)*

Crude oil, refined petroleum products, natural gas, and aluminum were the principal mineral products exported. The United States imported nearly 1 million barrels (Mbbl) of crude oil from the UAE in 1996 (Energy Information Administration, 1997). Japan was the primary customer for the UAE's mineral exports buying most of Abu Dhabi Gas Liquefaction Co.'s liquefied natural gas (LNG) production, almost 65% of produced petroleum, and about one-third of the aluminum output. Gold products were also exported, primarily to Asia and the Middle East.

The Government was heavily involved in the mineral industry, owning majority shares in the aluminum, fertilizer, natural gas, petroleum production and refining, and sulfur industries. It also had a significant presence in the cement industry. Nonetheless, private investor participation in the mineral sector continued to grow with the Government's encouragement. International petroleum companies were heavily involved in crude oil and natural gas development and infrastructure projects in Abu Dhabi. Expatriates accounted for about 75% of the Emirate's labor force.

In the metals sector, chromite mining in Fujairah by Derwent Mining Ltd. of Ireland continued. The Dubai Aluminum Co. Ltd. (Dubal) production exceeded a quarter million tons, potline by early 1997 were on target and should raise total capacity to 380,000 t/yr of aluminum. The smelter's products are chiefly billet, foundry alloy for automotive wheels, and high purity-ingot for electronics. Dubal expects to maximize sales of its higher value products, particularly foundry ingot shipments, which totaled 121,000 t in 1996. The size and infrastructure at the Jebel Ali site could support a 500,000-t/yr capacity smelter. A sixth 130,000-t/yr capacity potline is under consideration pending the lowering or removal of the 6% import tariff on unwrought metal deliveries to Europe from countries outside of the European Free Trade Association. Other metal operations included the Ahli Steel Co., which had a 70,000-t/yr steel plant for production of reinforcing bars in Dubai; Solo Industries Ltd., Sharjah, which operated an 800-t/yr lead refinery for scrap recycling; and Lucky Recycling Ltd., Dubai, which recycled copper scrap.

Within the industrial minerals sector, Ruwais Fertilizer Industries (FERTIL) continued to expand fertilizer exports. FERTIL proposed to increase its annual ammonia production capacity by 25%, to 500,000 t/yr, and urea production capacity by 15%, to 600,000 t/yr. Smaller fertilizer plants included a 219,000-t/yr plant at Ajman and the 6,000-t/yr Union Kemira plant at Jebel Ali, Dubai. Abu Dhabi National Oil Co.'s (ADNOC) subsidiary, National Chlorine Industries, produced caustic soda, chlorine, and salt at its plant in Umm Al-Nar. Expansion was underway at Fujairah Cement Industries in Dibba, Fujairah, and at the Ras al-Khaimah Co. for White Cement and Construction Material in Khor Kywair, Ras al-Khaimah.

The Government encouraged the expansion of hydrocarbon production capacity to ensure its participation in future world markets. The UAE increased sustainable crude petroleum production capacity from 2.3 Mbbl/d in 1991 to 2.46 Mbbl/d in 1996. Natural gas production capacity was expanded from 3.5

---

[1] Includes the following seven Emirates: Abu Dhabi, Dubai, Fujairah, Ras al-Khaimah, Sharjah, and Umm al-Qaywayn.

[2] Where necessary, values have been converted from Emirian dirhams (Dh) to U.S. dollars at the rate of Dh3.67=US$1.00.

million to 4.8 million cubic meters per day (Mm$^3$/d). Rapidly expanding electricity consumption and restrictions on oil production by OPEC quotas have prompted ADNOC to expand natural gas output by modernizing onshore and offshore gas extraction and distribution systems. Bechtel Corp. of the United States was part of a joint venture that was contracted to upgrade the gas-processing facilities at Habshan. This $1.3 billion onshore gas project for ADNOC will further development of the Thamama B, C, and F sour gas reservoirs. A projected natural gas flow of 42 Mm$^3$/d was to be treated to recover condensate and sulfur.

The Abu Dhabi Gas Liquefaction Co. supplies Tokyo Electric Power Co. with 50 million barrels per year of LNG under a contract extending to 2019.

Domestic and international oil companies' investment in increased production capacity has included drilling infill wells, upgrading wellhead equipment, and adding oil- and-gas gathering facilities, such as new trunklines, flowlines, and remote manifold stations. But the UAE's production was restrained by the OPEC quota, and onshore fields in Abu Dhabi were required by the Government to cut back on production. Operations in Dubai and high-cost offshore fields were permitted to produce at higher rates than the onshore Abu Dhabi concessions.

Exploration continued in the UAE with Dubai Petroleum Co. conducting marine seismic surveys adjacent to its offshore Fateh Field.

The Abu Dhabi Co. for Onshore Oil Operations procured four additional wellhead platforms and associated facilities for the offshore Umm Al-Anbar Field.

The Ruwais petroleum refinery was undergoing expansion and modernization. The project includes increasing distillation capacity by 335,000 bbl/d to 455,000 through the installation of a second 135,000-bbl/d crude distillation unit and a 200,000-bbl/d condensate distillation unit. Hydrocracking capacity was scheduled to be expanded from 27,000 to 73,000 bbl/d.

The UAE had proven petroleum reserves of 98 billion barrels as of January 1, 1996. Proven natural gas reserves were 6.12 trillion cubic meters. Most of the UAE's hydrocarbon reserves were in Abu Dhabi, the venue for 94% of petroleum reserves and 92% of natural gas reserves (Arab Petroleum Research Center, 1997).

The Nation's four government-run electric utilities had a total installed electricity-generating capacity of 5,500 megawatts. A number of gas-fired power and desalinization plants were under construction.

The UAE had an extensive crude oil and natural gas pipeline network. A 125-kilometer, 106-centimeter-diameter gas pipeline from Bab to the Taweelah B power station was under construction. Coastal petroleum terminals were at Ruwais, Jebel Dhanna, Port Zayed, and Umm Al-Nar in Abu Dhabi, Jebel Ali and Port Rashid in Dubai, and in Sharjah. Island or mooring buoy loading facilities were at Abu Al-Bukhoosh, Das Island, Delma Island, Mubarraz, and Zirku Island in Abu Dhabi, Fateh in Dubai, and Mubarak in Sharjah.

Privatization, expanding economic interests, and Government support should encourage growth for the mineral industry. Revenues from mineral fuels continued to be reinvested in diversification projects and downstream processing. The country's port facilities and merchandising capabilities were expected to attract additional precious metal and stone companies further expanding trans-shipment commerce. Favorable crude oil prices will be critical in implementing the nation's development programs particularly as large-scale investments will be needed early in the next century to boost power and water outputs necessary to support planned development.

## References Cited

Arab Petroleum Research Center, 1997, United Arab Emirates, Arab oil and gas directory: Paris, Arab Petroleum Research Center, p. 454-507.

Energy Information Administration, 1997, Petroleum supply annual-1996: Washington, D.C.: Government Printing Office, vol. 2, 599p.

## Major Sources of Information

Ministry of Petroleum and Mineral Resources
P.O. Box 59
Abu Dhabi, United Arab Emirates
Fax: (971) (2) 663-414
Mineral Department
Telephone: (971) (2) 661-102
Fax: (971) (2) 663-414
Abu Dhabi National Oil Co. (ADNOC)
P.O. Box 898
Abu Dhabi, United Arab Emirates
Telephone: (971) (2) 666-000
Fax: (971) (2) 602-3389
Abu Dhabi Gas Liquefaction Co. (ADGAS)
P.O. Box 3500
Abu Dhabi, United Arab Emirates
Telephone: (971) (2) 333-888
Fax: (971) (2) 606-5456
Dubai Petroleum Co.
P.O. Box 2222
Dubai, United Arab Emirates
Telephone: (971) (4) 442-990
Ras Al-Khaimah Oil & Gas Co. Ltd.
P.O. Box 2409
Ras Al-Khaimah, United Arab Emirates
Telephone: (971) (7) 210-055
Fax: (971) (7) 210-066

TABLE 1

UNITED ARAB EMIRATES: PRODUCTION OF MINERAL COMMODITIES 1/

(Metric tons unless otherwise specified)

| Commodity 2/ | | 1992 | 1993 | 1994 | 1995 | 1996 e/ |
|---|---|---|---|---|---|---|
| Aluminum, metal, primary ingot | | 244,605 | 242,264 | 246,890 | 239,900 | 250,500 3/ |
| Cement, hydraulic e/ 4/ | thousand tons | 3,800 3/ | 4,000 | 5,000 | 6,000 | 6,000 |
| Chromite, gross weight | | 1,000 | 19,000 r/ | 55,000 r/ | 37,000 r/ | 56,000 |
| Fertilizer materials: | | | | | | |
| Ammonia: | | | | | | |
| Gross weight | | 332,000 | 372,000 | 347,500 | 441,000 | 445,000 |
| N content | | 275,000 | 305,600 | 286,500 | 362,700 | 365,000 |
| Urea: | | | | | | |
| Gross weight e/ | | 506,000 | 520,000 | 540,000 | 540,000 | 540,000 |
| N content | | 236,000 | 243,000 | 250,000 e/ | 250,000 e/ | 250,000 |
| Gas, natural: | | | | | | |
| Gross | million cubic meters | 30,130 | 31,630 | 32,000 | 40,000 e/ | 47,000 |
| Dry | do. | 22,170 | 22,930 | 23,000 | 30,000 e/ | 40,000 |
| Gypsum e/ | thousand tons | 95 | 95 | 95 | 90 | 90 |
| Lime e/ | do. | 45 | 45 | 45 | 50 | 50 |
| Natural gas plant liquids e/ | thousand 42-gallon barrels | 52,500 | 58,000 | 80,000 | 100,000 | 110,000 |
| Petroleum: | | | | | | |
| Crude | do. | 836,000 | 800,000 | 792,000 | 800,500 | 831,000 3/ |
| Refinery products: | | | | | | |
| Gasoline | do. | 10,770 | 11,132 r/ | 11,970 r/ | 12,738 r/ | 13,000 |
| Kerosene | do. | 9,200 | 9,700 r/ | 10,110 r/ | 21,243 r/ | 11,000 |
| Distillate fuels | do. | 19,565 | 19,890 r/ | 21,681 r/ | 24,345 r/ | 25,000 |
| Residual fuels | do. | 18,940 | 19,856 r/ | 21,863 r/ | 12,995 r/ | 20,000 |
| Other | do. | 10,800 | 10,100 r/ | 10,475 r/ | 12,665 r/ | 13,000 |
| Total | do. | 69,275 | 70,678 r/ | 76,099 r/ | 83,986 r/ | 82,000 |
| Sulfur, byproduct: e/ | | | | | | |
| From petroleum refining | | 20,000 | 24,000 | 24,500 | 26,000 r/ | 26,000 |
| From natural gas processing | | 200,000 | 225,000 | 225,500 | 230,500 | 233,000 |
| Total | | 220,000 3/ | 249,000 3/ | 250,000 | 256,500 r/ | 259,000 |

e/ Estimated. r/ Revised.

1/ Table includes data available through Dec. 31, 1997.

2/ In addition to the commodities listed, crude industrial minerals such as common clays, diabase, gravel, limestone, marble, sand and shale presumably are produced, but output is not reported, and general information is inadequate to make reliable estimates of output levels.

3/ Reported figure.

4/ Includes white cement.

### THE MINERAL INDUSTRY OF

# THE REPUBLIC OF YEMEN

### By Bernadette Michalski

Yemen's mineral industry was dominated by crude oil production and natural gas liquids recovered from associated natural gas. While natural gas reserves were significant, few installations were currently in place to recover and utilize natural gas. Plans call for a liquefied natural gas (LNG) plant with a projected annual capacity of 5 million metric tons (Mt). Feedstock for the plant was to be nonassociated gas from the Marib-Al Jawf area. LNG exports were scheduled to commence in the year 2000. Other mineral output included dimension stone, gypsum, salt, and the manufacture of cement. It is probable that, in the near future, mineral output will include commercial gold production.

The Republic of Yemen formulated mining legislation guaranteeing the rights of private property in the mining of most mineral commodities. The royalty rate due to the Government in any mining operation is 5% on precious metals and 3% on other minerals. The precious stone and hydrocarbon industries remained the exclusive domain of the Government. In an effort to accelerate exploration and development, the Government entered into multiple-exploration and production-sharing agreements with private companies offering both expertise and capital.

Crude oil production averaged about 354,000 barrels per day (bbl/d) in 1996. More than one-half of the production was derived from the Masila Fields. Production from the Shabwa region never exceeded 5,000 bbl/d and was discontinued in 1994. *(See table 1.)*

Crude oil production from the Jannah Bloc (Halewah) commenced in the third quarter of 1996 at 5,000 bbl/d rising to 15,000 bbl/d before yearend. Petroleum accounted for more than four-fifths of the Republic of Yemen's total export earnings. Revenues were appreciably augmented when the Masila Fields came on-stream in mid-1993, eventually raising annual exports by approximately 60 million barrels (Mbbl). Total petroleum exports in 1996 were approximately 100 Mbbl. Most of these exports were destined for Asian markets; however, the United States imported more than 1 Mbbl of crude and unfinished oils in 1996. The Yemeni Government liberalized import regulations for a number of commodities related to the construction and agricultural industries. These included cement, iron and steel manufactures, and fertilizers. Individual import licenses have the following ceilings: 15,000 metric tons for cement, $600,000 for iron products, and $350,000 for fertilizers.

Menora Resources of Canada announced that the Wadi Medden gold deposit consists of nine main gold-bearing zones hosting a resource of 590,000 t at an average grade of 14.7 grams of gold per metric ton. The company plans to undertake a US$1.2 million drilling program to improve the verticle definition of the deposit. The program includes 4,800 meters (m) of surface drilling in 16 holes and 1,230 m of underground drilling in 17 holes (Mining Journal, 1996).

The Yemen Corp. for the Production and Marketing of Cement awarded a design and construction supervision contract for the Al Buh cement works near Mafrag. The 500,000-metric-ton-per-year capacity cement plant was financed by Japan's Overseas Economic Cooperation Fund at $145 million. Completion of this project was expected to raise Yemen's total annual cement production capacity to 1.25 Mt.

Associated natural gas production was separated and stripped of natural gas liquids. The remaining gas was reinjected at the rate of 18 million cubic meters per day. Plans progressed on schedule for the development of the Marib-Al Jawf nonassociated natural gas reservoir including a 380 kilometer pipeline, processing plant, and export terminal construction in Balhaf on the Gulf of Aden. A consortium was established with Total SA of France as project leader having 36% equity; Yemen General Gas Corp., 26%; Hunt Oil Co. of the United States, 14.6%; Exxon Corp. of the United States, 14.1%; and the Republic of Korea's Yukong Ltd., 9.3%. The consortium plans call for the production of 5 million metric tons per year of LNG over a 25-year period. The first phase is due to begin in September 1997, at an estimated cost of $2,600 million.

Yemen's crude oil production was derived from Canadian Occidental Petroleum's Masila Fields producing 40.4° API gravity crude oil and Yemen Exploration and Production Co. operations producing 30.5° API gravity crude oil in the Marib-Al Jawf region. Hunt Oil reportedly began production from the Halewah Field at the close of 1996. Initial production was anticipated at 10,000 bbl/d (Arab Oil and Gas Directory, 1997).

The Marib topping plant continued processing 10,000 bbl/d. The Aden Refinery processed about 100,000 bbl/d. About 40% of the refinery throughput was contract crude oil from Iran, Malaysia, and Oman. The Aden refinery was scheduled to undergo a modernization program, including the installation of a new control system, and the upgrading of the two crude distillation units and the reforming unit. After completion, capacity was expected to be between 150,000 to 170,000 bbl/d.

The combined estimated proven crude oil reserves of the Republic of Yemen were reported at 4 billion barrels concentrated in five areas: Marib-Al Jawf, East Shabwa, Masila, Jannah, and Iyad. Natural gas reserves were reported at 565 billion cubic meters, of which 200 billion cubic meters were proven reserves in the Marib-Al Jawf region (West,1996).

Yemen received commitments for assistance from various institutions totaling $500 million in 1996 to support the balance of payments and a reform program which includes measures aimed at liberalizing trade, privatizing state-owned enterprises, and improving investment conditions for the private sector. Furthermore, liberalized mining and petroleum exploration laws and foreign investment regulations have attracted not only foreign oil companies with development financing but metallic mineral exploration groups as well. With continued poilical stability, the prospect of further commercial finds was expected to be a realistic one.

### References Cited

Arab Oil and Gas Directory, 1997, Yemen: Arab Oil and Gas Directory: Paris, France, Arab Petroleum Research Center, p. 523.

Mining Journal, 1996, Yemen: Mining Journal, v. 326, no. 8404, November 29, p. 4

West, Jim ed., 1996, International Petroleum Encyclopedia: Tulsa, Oklahoma, Pennwell Publishing Company, 335 p.

### Major Sources of Information

The Petroleum and Mineral Resource Ministry
Sanaa, Republic of Yemen
The Ministry of Economy, Supply, and Trade
Sanaa, Republic of Yemen

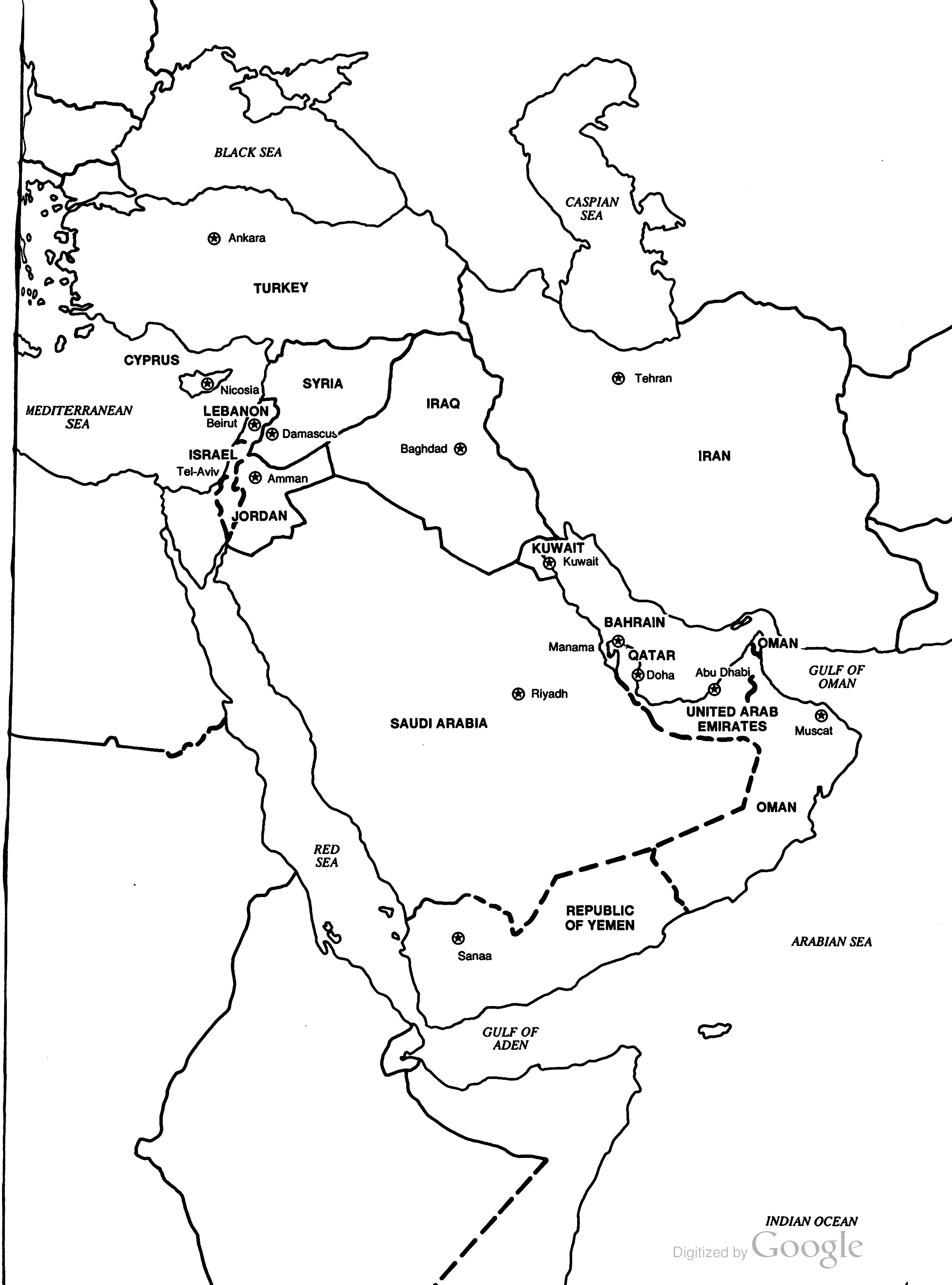
TABLE 1
REPUBLIC OF YEMEN: PRODUCTION OF MINERAL COMMODITIES 1/

| Commodity | | 1992 | 1993 | 1994 | 1995 | 1996 e/ |
|---|---|---|---|---|---|---|
| Cement | thousand metric tons | 800 2/ | 800 | 500 | 1,000 | 1,000 |
| Gypsum e/ | metric tons | 80,000 | 90,000 | 80,000 e/ | 80,000 e/ | 80,000 |
| Natural gas: | | | | | | |
| Gross e/ | million cubic meters | 80,000 | 90,000 | 100,000 | 100,000 | 100,000 |
| Liquids | thousand 42-gallon barrels | 40 | 2,600 | 2,600 e/ | 2,600 e/ | 2,600 |
| Petroleum: | | | | | | |
| Crude | do. | 62,000 | 87,600 | 122,275 | 127,750 | 129,200 |
| Refinery products: | | | | | | |
| Gasoline | do. | 9,600 | 10,000 | 8,000 e/ | 10,000 e/ | 10,000 |
| Kerosene | do. | 4,900 | 4,500 | 2,500 e/ | 3,500 e/ | 3,500 |
| Distillate fuel oil | do. | 13,700 | 13,000 | 10,500 e/ | 11,500 e/ | 11,500 |
| Residual fuel oil e/ | do. | 15,500 2/ | 15,500 | 12,000 | 15,000 | 15,000 |
| Other e/ | do. | 2,500 | 2,000 | 1,000 e/ | 2,000 e/ | 2,000 |
| Total e/ | do. | 46,200 2/ | 45,000 | 34,000 | 42,000 | 42,000 |
| Salt | metric tons | 107,000 | 110,000 | 110,000 | 110,000 | 110,000 |
| Stone: Dimension e/ | cubic meters | 410,000 | 410,000 | 410,000 | 410,000 | 410,000 |

e/ Estimated.
1/ Table includes data available through July 15, 1997.
2/ Reported figure.

RUTGERS THE STATE UNIVERSITY
3 9030 02529682 5

☆ U.S. GOVERNMENT PRINTING OFFICE: 1998—673-048 / 20118 Region No. 8


BLACK SEA
CASPIAN SEA
Ankara
TURKEY
CYPRUS
Nicosia
SYRIA
IRAQ
Tehran
MEDITERRANEAN SEA
LEBANON
Beirut
Damascus
Baghdad
IRAN
ISRAEL
Tel-Aviv
Amman
JORDAN
KUWAIT
Kuwait
BAHRAIN
Manama
QATAR
Doha
Abu Dhabi
OMAN
GULF OF OMAN
Riyadh
SAUDI ARABIA
UNITED ARAB EMIRATES
Muscat
OMAN
RED SEA
REPUBLIC OF YEMEN
Sanaa
ARABIAN SEA
GULF OF ADEN
INDIAN OCEAN